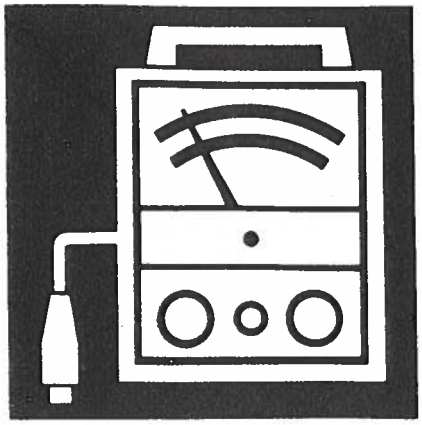
Chilton's Truck and Van Manual 1982-88
0-8019-7815-7

Troubleshooting and Diagnosis



ENGINE

Gasoline Engine Troubleshooting

See applicable Car or Unit Repair section for specific service procedures

INDEX TO PROBLEMS

Problem Symptom	Begin at Specific Diagnosis, Number
Engine Won't Start	
Starter doesn't turn	1.1, 2.1
Starter turns, engine doesn't	2.1
Starter turns engine very slowly	1.1, 2.4
Starter turns engine normally	3.1, 4.1
Starter turns engine very quickly	6.1
Engine fires intermittently	4.1
Engine fires consistently	5.1, 6.1
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Hard starting	3.1, 4.1, 5.1, 8.1
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Stalling	3.1, 4.1, 5.1, 8.1
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Lack of power	3.1, 4.1, 5.1, 8.1
Backfire through the carburetor	4.1, 8.1, 9.1
Backfire through the exhaust	4.1, 8.1, 9.1
Blue exhaust gases	6.1, 7.1
Black exhaust gases	5.1
Running on (after the ignition is shut off)	3.1, 8.1
Susceptible to moisture	4.1
Engine misfires under load	4.1, 7.1, 8.4, 9.1
Engine misfires at speed	4.1, 8.4
Engine misfires at idle	3.1, 4.1, 5.1, 7.1, 8.4

SAMPLE SECTION

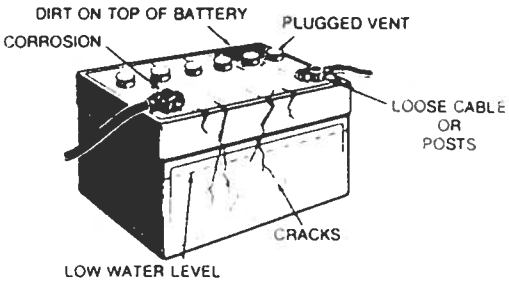
Test and Procedure	Results and Indications	Proceed to
4.1 Check for spark: Hold each spark plug wire approximately ¼" from ground with gloves or a heavy, dry rag. Crank the engine and observe the spark.	If no spark is evident	4.2
	If spark is good in some cases	4.3
	If spark is good in all cases	4.6

SPECIFIC DIAGNOSIS

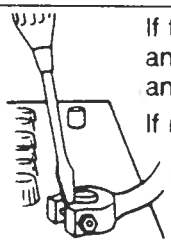
This section is arranged so that following each test, instructions are given to proceed to another, until a problem is diagnosed.

SECTION 1—BATTERY

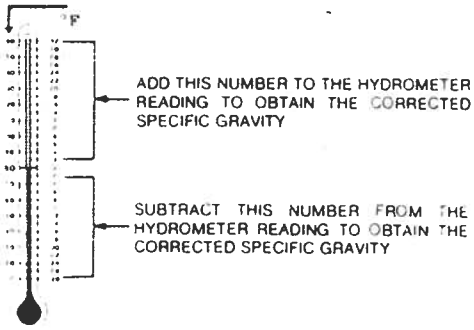
Test and Procedure	Results and Indications	Proceed to
1.1 Inspect the battery visually for case condition (corrosion, cracks) and water level.	If case is cracked, replace battery.	1.4
	If the case is intact, remove corrosion with a solution of baking soda and water. **(CAUTION: Do not get the solution into the battery).** Fill with water.	1.2
1.2 Check the battery cable connections: Insert a screwdriver between the battery post and the cable clamp. Turn the headlights on high beam, and observe them as the screwdriver is gently twisted to ensure good metal to metal contact.	If the lights brighten, remove and clean the clamp and post; coat the post with petroleum jelly, install and tighten the clamp.	1.4
	If no improvement is noted	1.3
1.3 Test the state of charge of the battery using an individual cell tester or hydrometer.	If indicated, charge the battery. **NOTE: If no obvious reason exists for the low state of charge (i.e., battery age, prolonged storage), proceed to:**	1.4



Inspect the battery case



TESTING BATTERY CABLE CONNECTIONS USING A SCREWDRIVER



Specific Gravity (@ 80° F.)

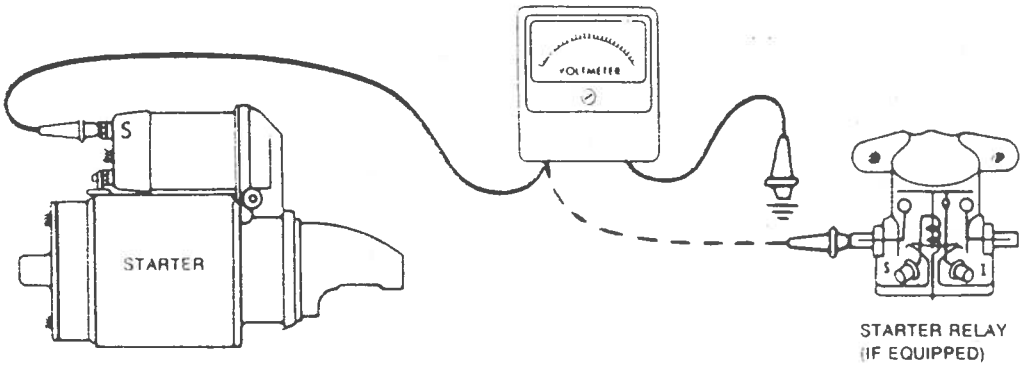
Minimum	*Battery Charge*
1.260	100% Charged
1.230	75% Charged
1.200	50% Charged
1.170	25% Charged
1.140	Very Little Power Left
1.110	Completely Discharged

The effects of temperature on battery specific gravity (left) and amount of battery charge in relation to specific gravity (right)

Test and Procedure	Results and Indications	Proceed To
1.4 Visually inspect battery cables for cracking, bad connection to ground, or bad connection to starter.	If necessary, tighten connections or replace the cables.	2.1

SECTION 2—STARTING SYSTEM

Test and Procedure	Results and Indications	Proceed to
Note: Tests in Group 2 are performed with coil high tension lead disconnected to prevent accidental starting.		
2.1 Test the starter motor and solenoid: Connect a jumper from the battery post of the solenoid (or relay) to the starter post of the solenoid (or relay).	If starter turns the engine normally	2.2
	If the starter buzzes, or turns the engine very slowly	2.4
	If no response, replace the solenoid (or relay).	3.1
	If the starter turns, but the engine doesn't, ensure that the flywheel ring gear is intact. If the gear is undamaged, replace the starter drive.	3.1
2.2 Determine whether ignition override switches are functioning properly (clutch start switch, neutral safety switch), by connecting a jumper across the switch(es), and turning the ignition switch to "start".	If starter operates, adjust or replace switch.	3.1
	If the starter doesn't operate	2.3
2.3 Check the ignition switch "start" position: Connect a 12V test lamp or voltmeter between the starter post of the solenoid (or relay) and ground. Turn the ignition switch to the "start" position, and jiggle the key.	If the lamp doesn't light or the meter needle doesn't move when the switch is turned, check the ignition switch for loose connections, cracked insulation, or broken wires. Repair or replace as necessary.	3.1
	If the lamp flickers or needle moves when the key is jiggled, replace the ignition switch.	3.3



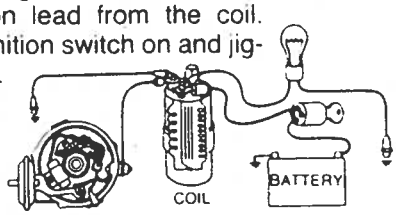
Checking the ignition switch "start" position

2.4 Remove and bench test the starter, according to specifications in the car section.	If the starter does not meet specifications, repair or replace as needed	3.1
	If the starter is operating properly	2.5

Test and Procedure	Results and Indications	Proceed To
2.5 Determine whether the engine can turn freely: Remove the spark plugs, and check for water in the cylinders. Check for water on the dipstick, or oil in the radiator. Attempt to turn the engine using an 18" flex drive and socket on the crankshaft pulley nut or bolt.	If the engine will turn freely only with the spark plugs out, and hydrostatic lock (water in the cylinders) is ruled out, check valve timing.	9.2
	If engine will not turn freely, and it is known that the clutch and transmission are free, the engine must be disassembled for further evaluation.	See Car Section

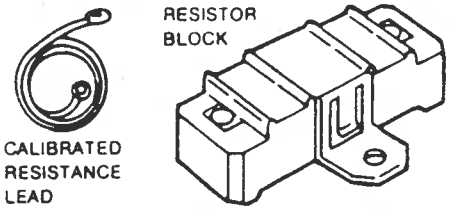
SECTION 3—PRIMARY ELECTRICAL SYSTEM

Test and Procedure	Results and Indications	Proceed to
3.1 Check the ignition switch "on" position: Connect a jumper wire between the distributor side of the coil and ground, and a 12V test lamp between the switch side of the coil and ground. Remove the high tension lead from the coil. Turn the ignition switch on and jiggle the key.	If the lamp lights	3.2
	If the lamp flickers when the key is jiggled, replace the ignition switch.	3.3
	If the lamp doesn't light, check for loose or open connections. If none are found, remove the ignition switch and check for continuity. If the switch is faulty, replace it.	3.3



Checking the ignition switch "on" position

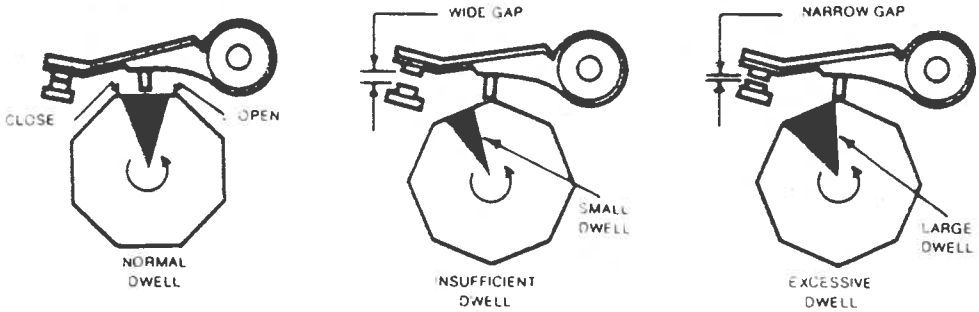
3.2 Check the ballast resistor or resistance wire for an open circuit, using an ohmmeter.	Replace the resistor or resistance wire if the resistance is zero. **NOTE: Some ignition systems have no ballast resistor.**	3.3



Two types of resistors

3.3 On point-type ignition systems, visually inspect the breaker points for burning, pitting or excessive wear. Gray coloring of the point contact surfaces is normal. Rotate the crankshaft until the contact heel rests on a high point of the distributor cam and adjust the point gap to specifications. On electronic ignition models, remove the distributor cap and visually inspect the armature. Ensure that the armature pin is in place, and that the armature is on tight and rotates when the engine is cranked. Make sure there are no cracks, chips or rounded edges on the armature.	If the breaker points are intact, clean the contact surfaces with fine emery cloth, and adjust the point gap to specifications. If the points are worn, replace them. On electronic systems, replace any parts which appear defective. If condition persists	3.4

Test and Procedure	Results and Indications	Proceed To
3.4 On point-type ignition systems, connect a dwell-meter between the distributor primary lead and ground. Crank the engine and observe the point dwell angle. On electronic ignition systems, conduct a stator (magnetic pickup assembly) test. See Electronic Ignition Unit Repair Section.	On point-type systems, adjust the dwell angle if necessary. **NOTE: Increasing the point gap decreases the dwell angle and vice-versa.** If the dwell meter shows little or no reading On electronic ignition systems, if the stator is bad, replace the stator. If the stator is good, proceed to the other tests in The Electronic Ignition Unit Repair Section.	**3.6** **3.5**

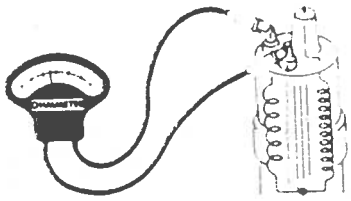


Dwell is a function of point gap

3.5 On the point-type ignition systems, check the condenser for short: connect an ohmeter across the condenser body and the pigtail lead.	If any reading other than infinite is noted, replace the condenser	**3.6**

Checking the condenser for short

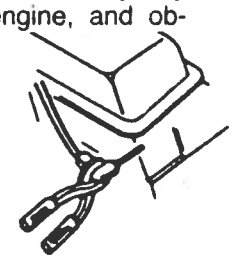
3.6 Test the coil primary resistance: On point-type ignition systems, connect an ohmmeter across the coil primary terminals, and read the resistance on the low scale. Note whether an external ballast resistor or resistance wire is used. On electronic ignition systems, test the coil primary resistance.	Point-type ignition coils utilizing ballast resistors or resistance wires should have approximately 1.0 ohms resistance. Coils with internal resistors should have approximately 4.0 ohms resistance. If values far from the above are noted, replace the coil.	**4.1**



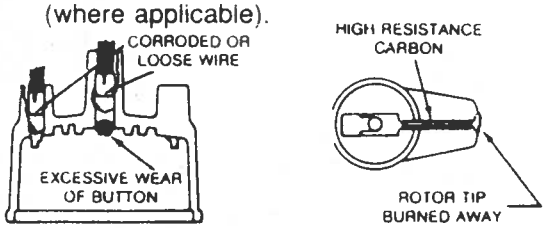
Checking the coil primary resistance

SECTION 4—SECONDARY ELECTRICAL SYSTEM

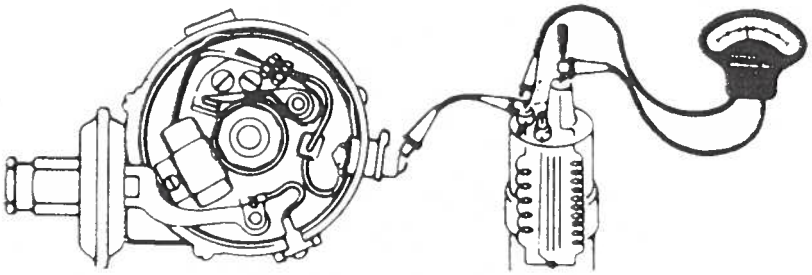
Test and Procedure	Results and Indications	Proceed to
4.1 Check for spark: Hold each spark plug wire approximately ¼" from ground with gloves or heavy, dry rag. Crank the engine, and observe the spark.	If no spark is evident	4.2
	If spark is good in some cylinders	4.3
	If spark is good in all cylinders	4.6
4.2 Check for spark at the coil high tension lead: Remove the coil high tension lead from the distributor and position it approximately ¼" from ground. Crank the engine and observe spark. **CAUTION: This test should not be performed on engines equipped with electronic ignition.**	If the spark is good and consistent	4.3
	If the spark is good but intermittent, test the primary electrical system starting at 3.3.	3.3
	If the spark is weak or non-existent, replace the coil high tension lead, clean and tighten all connections and retest. If no improvement is noted	4.4
4.3 Visually inspect the distributor cap and rotor for burned or corroded contacts, cracks, carbon tracks, or moisture. Also check the fit of the rotor on the distributor shaft (where applicable).	If moisture is present, dry thoroughly, and retest per 4.1.	4.1
	If burned or excessively corroded contacts, cracks, or carbon tracks are noted, replace the defective part(s) and retest per 4.1.	4.1
	If the rotor and cap appear intact, or are only slightly corroded, clean the contacts thoroughly (including the cap towers and spark plug wire ends) and retest per 4.1.	
	If the spark is good in all cases	4.6
	If the spark is poor in all cases	4.5
4.4 Check the coil secondary resistance: On point-type systems connect an ohmmeter across the distributor side of the coil and the coil tower. Read the resistance on the high scale of the ohmmeter. On electronic ignition systems, see The Electronic Ignition Unit Repair Section for specific tests.	The resistance of a satisfactory coil should be between 4,000 and 10,000 ohms. If resistance is considerably higher (i.e., 40,000 ohms) replace the coil and retest per 4.1. **NOTE: This does not apply to high performance coils.**	



Check for spark at the plugs



Inspect the distributor cap and rotor



Testing the coil secondary resistance

Spark Plug Analysis

Normal

APPEARANCE

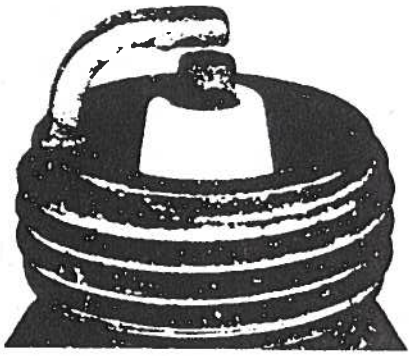
This plug is typical of one operating normally. The insulator nose varies from a light tan to grayish color with slight electrode wear. The presence of slight deposits is normal on used plugs and will have no adverse effect on engine performance. The spark plug heat range is correct for the engine and the engine is running normally.

CAUSE

Properly running engine

RECOMMENDATION

Before reinstalling this plug, the electrodes should be cleaned and filed square. Set the gap to specifications. If the plug has been in service for more than 10–12,000 miles, the entire set should probably be replaced with a fresh set of the same heat range.



Incorrect Heat Range

APPEARANCE

The effects of high temperature on a spark plug are indicated by clean white, often blistered insulator. This can also be accompanied by excessive wear of the electrode, and the absence of deposits.

CAUSE

Check for the correct spark plug heat range. A plug which is too hot for the engine can result in overheating. A car operated mostly at high speeds may require a colder plug. Also check ignition timing, cooling system level, fuel mixture and leaking intake manifold.

RECOMMENDATION

If all ignition and engine adjustments are known to be correct, and no other malfunction exists, install spark plugs one heat range colder.

Oil Deposits

APPEARANCE

The firing end of the plug is covered with a wet, oily coating.

CAUSE

The problem is poor oil control. On high mileage engines, oil is leaking past the rings or valve guides into the combustion chamber. A common cause is also a plugged PCV valve, and a ruptured fuel pump diaphragm can also cause this condition. Oil fouled plugs such as these are often found in new or recently overhauled engines, before normal oil control is achieved, and can be cleaned and reinstalled.

RECOMMENDATION

A hotter spark plug may temporarily relieve the problem, but the engine is probably in need of engine work.

Carbon Deposits

APPEARANCE

Carbon fouling is easily identified by the presence of dry, soft, black, sooty deposits.

CAUSE

Changing the heat range can often lead to carbon fouling, as can prolonged slow, stop-and-start driving. If the heat range is correct, carbon fouling can be attributed to a rich fuel mixture, sticking choke, clogged air cleaner, worn breaker points, retarded timing or low compression. If only one or two plugs are carbon fouled, check for corroded or cracked wires on the affected plugs. Also look for cracks in the distributor cap between the towers of affected cylinders.

RECOMMENDATION

After the problem is corrected, these plugs can be cleaned and reinstalled if not worn severely.

Ash Deposits

APPEARANCE

Ash deposits are characterized by light brown or white colored deposits crusted on the side or center electrodes. In some cases it may give the plug a rusty appearance.

CAUSE

Ash deposits are normally derived from oil or fuel additives burned during normal combustion. Normally they are harmless, though excessive amounts can cause misfiring. If deposits are excessive in short mileage, the valve guides may be worn. Reddish or rusty deposits are caused by manganese, an anti-knock compound replacing lead in unleaded gas. No engine malfunction is indicated.

RECOMMENDATION

Ash-fouled plugs can be cleaned, gapped and reinstalled.

Splash Deposits

APPEARANCE

Splash deposits occur in varying degrees as spotty deposits on the insulator.

CAUSE

These usually occur after a long delayed tune-up. By-products of combustion have accumulated on pistons and valves because of a delayed tune-up. Following tune-up or during hard acceleration, the deposits loosen and are thrown against the hot surface of the plug. If the deposits accumulate sufficiently, misfiring can occur.

RECOMMENDATION

These plugs can be cleaned, gapped and reinstalled.

High Speed Glazing

APPEARANCE

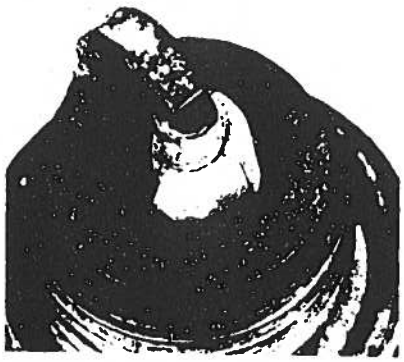
Glazing appears as shiny coating on the plug, either yellow or tan in color.

CAUSE

During hard, fast acceleration, plug temperatures rise suddenly. Deposits from normal combustion have no chance to fluff-off; instead, they melt on the insulator forming an electrically conductive coating which causes misfiring.

RECOMMENDATION

Glazed plugs are not easily cleaned. They should be replaced with a fresh set of plugs of the correct heat range. If the condition recurs, using plugs with a heat range one step colder may cure the problem.



Detonation

APPEARANCE

Detonation is usually characterized by a broken plug insulator.

CAUSE

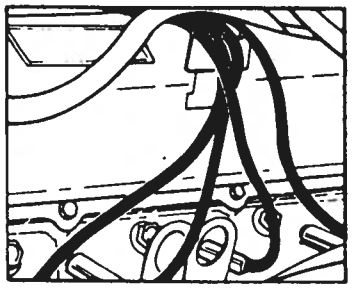
A portion of the fuel charge will begin to burn spontaneously, from the increased heat following ignition. The explosion that results applies extreme pressure to engine components, frequently damaging spark plugs and pistons.

Detonation can result by over-advanced ignition timing, inferior gasoline (low octane) lean air fuel mixture, poor carburetion, engine lugging or an increase in compression ratio due to combustion chamber deposits or engine modification.

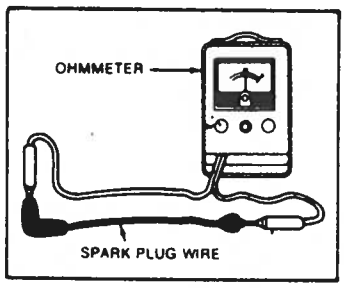
RECOMMENDATION

Replace the plugs after correcting the problem.

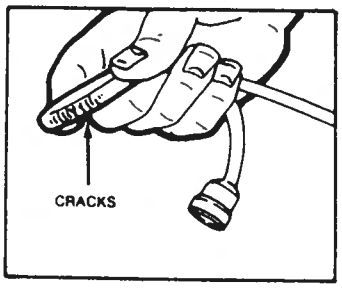
Test and Procedure	Results and Indications	Proceed To
4.5 Visually inspect the spark plug wires for cracking or brittleness. Ensure that no two wires are positioned so as to cause induction firing (adjacent and parallel). Remove each wire, one by one, and check resistance with an ohmmeter.	Replace any cracked or brittle wires. If any of the wires are defective, replace the entire set. Replace any wires with excessive resistance (over 8000 Ω per foot for suppression wire), and separate any wires that might cause induction firing.	**4.6**



Misfiring can be the result of spark plug leads to adjacent, consecutively firing cylinders running parallel and too close together



On point-type ignition systems, check the spark plug wires as shown. On electronic ignitions, do not remove the wire from the distributor cap terminal; instead, test through the cap



Spark plugs wires can be checked visually by bending them in a loop over your finger. This will reveal any cracks, burned or broken insulation. Any wire with cracked insulation should be replaced

4.6 Remove the spark plugs, noting the cylinders from which they were removed, and evaluate according to the chart in this section.	See chart.	**See Chart**

4.7 Reinstall the spark plugs.

NOTE: Modern electronic ignition systems generate extremely high voltages and high heats. The spark plug boots can soften and actually fuse to the ceramic insulator of the spark plugs after long exposures to high temperature and voltage. If this happens, the boot (and possibly the wire) must be replaced.

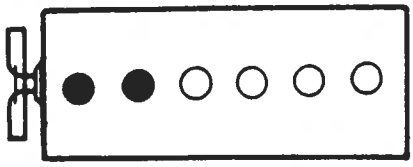
To help alleviate this condition, many manufacturers are recommending new silicone compounds to slow the deterioration. The compounds are generally nonconductive, protective lubricants that will not dry out, harden, or melt away. They form a weather-tight seal between rubber or plastic and metal and are found in several typical locations: inside the insulating boots of spark plug wires, inside primary ignition circuit cable connectors, on distributor and rotor cap electrodes, and under the GM HEI control module.

4.8

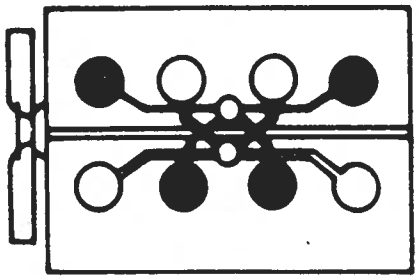
Application Point	Silicone Compound
GENERAL MOTORS: Under HEI module	Supplied with new module, or use GE-642 or DC-340
FORD MOTOR COMPANY: Inside spark plug boots, on end of cable when installing new boot, and on rotor and cap electrodes	Ford part number D7AZ-19A331-A or use GE-627 or DC-111
CHRYSLER CORPORATION: ¼" deep within spark control computer connector cavity coating rotor electrode	Use Mopar part number 2932524 or NLGI Grade 2 EP (not a silicone) supplied with new rotor, or use GE-628 or DC-111
AMERICAN MOTORS (Prestolite system): Distributor primary connector—coat male terminal, fill female ¼ full	AMC part number 8127445 or GE-623

GE: General Electric
DC: Dow Corning

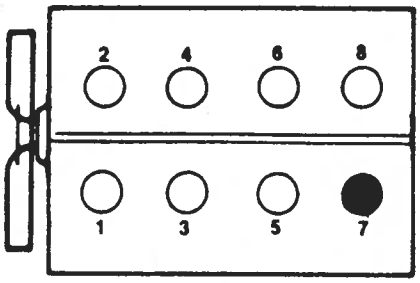
Test and Procedure	Results and Indications	Proceed To
4.8 Examine the location of all the plugs.	The following diagrams illustrate some of the conditions that the location of plugs will reveal.	**4.9**



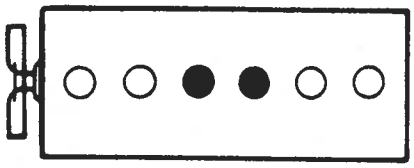
Two adjacent plugs are fouled in a 6-cylinder engine, 4-cylinder engine or either bank of a V-8. This is probably due to a blown head gasket between the two cylinders.



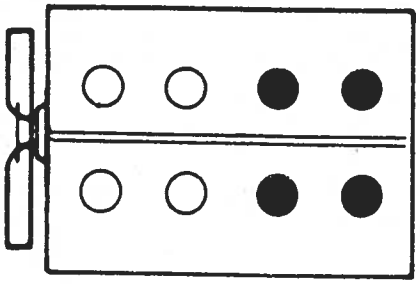
An unbalanced carburetor is indicated. Following the fuel flow on this particular design shows that the cylinders fed by the right-hand barrel are fouled from overly rich mixture, while the cylinders fed by the left-hand barrel are normal.



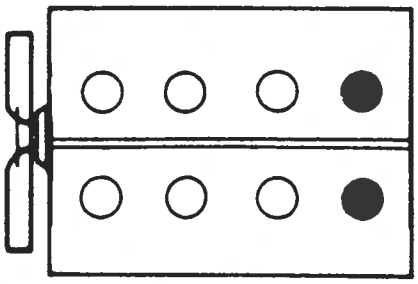
Finding one plug overheated may indicate an intake manifold leak near the affected cylinder. If the overheated plug is the second of two adjacent, consecutively firing plugs, it could be the result of ignition cross-firing. Separating the leads to these two plugs will eliminate cross-fire.



The two center plugs in a 6-cylinder engine are fouled. Raw fuel may be "boiled" out of the carburetor into the intake manifold after the engine is shut-off. Stop-start driving can also foul the center plugs, due to overly rich mixture. Proper float level, a new float needle and seat or use of an insulating spacer may help this problem.



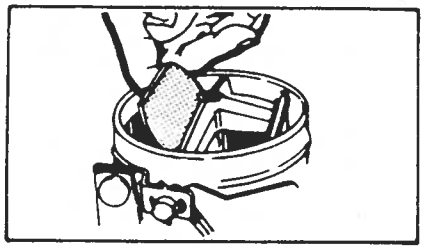
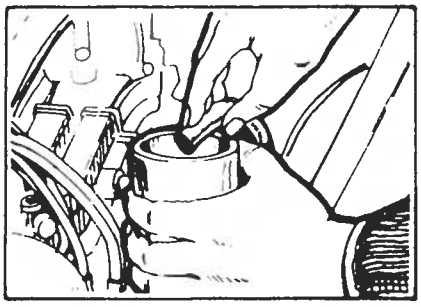
If the four rear plugs are overheated, a cooling system problem is suggested. A thorough cleaning of the cooling system may restore coolant circulation and cure the problem.



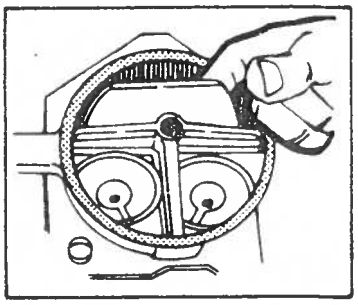
Occasionally, the two rear plugs in large, lightly used V-8's will become oil fouled. High oil consumption and smoky exhaust may also be noticed. It is probably due to plugged oil drain holes in the rear of the cylinder head, causing oil to be sucked in around the valve stems. This usually occurs in the rear cylinders first, because the engine slants that way.

Test and Procedure	Results and Indications	Proceed To
4.9 Determine the static ignition timing. Using the crankshaft pulley timing marks as a guide, locate top dead center on the compression stroke of the number one cylinder.	The rotor should be pointing toward the No. 1 tower in the distributor cap, and, on electronic ignitions, the armature spoke for that cylinder should be lined up with the stator.	**4.10**
4.10 Check coil polarity: Connect a voltmeter negative lead to the coil high tension lead, and the positive lead to ground. **NOTE: Reverse the hook-up for positive ground systems.** Crank the engine momentarily. **Checking coil polarity**	If the voltmeter reads up-scale, the polarity is correct. If the voltmeter reads down-scale, reverse the coil polarity (switch the primary leads).	**5.1** **5.1**

SECTION 5—FUEL SYSTEM

Test and Procedure	Results and Indications	Proceed to
5.1 Determine that the air filter is functioning efficiently: Hold paper elements up to a strong light, and attempt to see light through the filter.	Clean permanent air filters in solvent (or manufacturer's recommendation), and allow to dry. Replace paper elements through which light cannot be seen.	**5.2**
5.2 Determine whether a flooding condition exists: Flooding is identified by a strong gasoline odor, and excessive gasoline present in the throttle bore(s) of the carburetor.  **If the engine floods repeatedly, check the choke butterfly flap**	If flooding is not evident If flooding is evident, permit the gasoline to dry for a few moments and restart. If flooding doesn't recur If flooding is persistent	**5.3** **5.7** **5.5**
5.3 Check that fuel is reaching the carburetor: Detach the fuel line at the carburetor inlet. Hold the end of the line in a cup (not styrofoam), and crank the engine.  **Check the fuel pump by disconnecting the output line (fuel pump-to-carburetor) at the carburetor and operating the starter briefly**	If fuel flows smoothly If fuel doesn't flow If fuel flows erratically. **NOTE: Make sure that there is fuel in the tank**	**5.7** **5.4**

Test and Procedure	Results and Indications	Proceed To
5.4 Test the fuel pump: Disconnect all fuel lines from the fuel pump. Hold a finger over the input fitting, crank the engine (with electric pump, turn the ignition or pump on); and feel for suction.	If suction is evident, blow out the fuel line to the tank with low pressure compressed air until bubbling is heard from the fuel filler neck. Also blow out the carburetor fuel line (both ends disconnected).	5.7
	If no suction is evident, replace or repair the fuel pump. **NOTE: Repeated oil fouling of the spark plugs, or a no-start condition, could be the result of a ruptured vacuum booster pump diaphragm, through which oil or gasoline is being drawn into the intake manifold (where applicable).**	5.7
5.5 Occasionally, small specks of dirt will clog the small jets and orifices in the carburetor. With the engine cold, hold a flat piece of wood or similar material over the carburetor, where possible, and crank the engine.	If the engine starts, but runs roughly the engine is probably not run enough.	
	If the engine won't start.	5.9
5.6 Check the needle and seat: Tap the carburetor in the area of the needle and seat.	If flooding stops, a gasoline additive (e.g., Gumout) will often cure the problem.	5.7
	If flooding continues, check the fuel pump for excessive pressure at the carburetor (according to specifications). If the pressure is normal, the needle and seat must be removed and checked, and/or the float level adjusted.	5.7
5.7 Test the accelerator pump by looking into the throttle bores while operating the throttle.	If the accelerator pump appears to be operating normally	5.8
	If the accelerator pump is not operating, the pump must be reconditioned. Where possible, service the pump with the carburetor(s) installed on the engine. If necessary, remove the carburetor. Prior to removal	5.8
5.8 Determine whether the carburetor main fuel system is functioning: Spray a commercial starting fluid into the carburetor while attempting to start the engine.	If the engine starts, runs for a few seconds, and dies	5.9
	If the engine doesn't start	6.1
5.9 Uncommon fuel system malfunctions: See below:	If the problem is solved	6.1
	If the problem remains, remove and recondition the carburetor.	



Check for gas at the carburetor by looking down the carburetor throat while someone moves the accelerator

Condition	Indication	Test	Prevailing Weather Conditions	Remedy
Vapor lock	Engine will not restart shortly after running.	Cool the components of the fuel system until the engine starts. Vapor lock can be cured faster by draping a wet cloth over a mechanical fuel pump.	Hot to very hot	Ensure that the exhaust manifold heat control valve is operating. Check with the vehicle manufacturer for the recommended solution to vapor lock on the model in question.
Carburetor icing	Engine will not idle, stalls at low speeds.	Visually inspect the throttle plate area of the throttle bores for frost.	High humidity, 32–40° F.	Ensure that the exhaust manifold heat control valve is operating, and that the intake manifold heat riser is not blocked.
Water in the fuel	Engine sputters and stalls; may not start.	Pump a small amount of fuel into a glass jar. Allow to stand, and inspect for droplets of a layer of water.	High humidity, extreme temperature changes.	For droplets, use one or two cans of commercial gas line anti-freeze. For a layer of water, the tank must be drained, and the fuel lines blown out with compressed air.

SECTION 6—ENGINE COMPRESSION

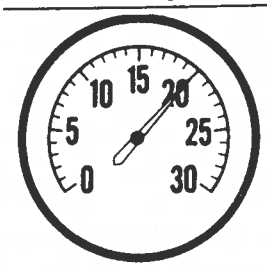
Test and Procedure	Results and Indications	Proceed to
6.1 Test engine compression: Remove all spark plugs. Block the throttle wide open. Insert a compression gauge into a spark plug port, crank the engine to obtain the maximum reading, and record.	If compression is within limits on all cylinders	7.1
	If gauge reading is extremely low on all cylinders	6.2
	If gauge reading is low on one or two cylinders: (If gauge readings are identical and low on two or more adjacent cylinders, the head gasket must be replaced.)	6.2

Checking compression

6.2 Test engine compression (wet): Squirt approximately 30 cc. of engine oil into each cylinder, and retest per 6.1.	If the readings improve, worn or cracked rings or broken pistons are indicated:	See Car Section
	If the readings do not improve, burned or excessively carboned valves or a jumped timing chain are indicated. **NOTE: A jumped timing chain is often indicated by difficult cranking.**	7.1

SECTION 7—ENGINE VACUUM

Test and Procedure	Results and Indications	Proceed to
7.1 Attach a vacuum gauge to the intake manifold beyond the throttle plate. Start the engine, and observe the action of the needle over the range of engine speeds.	See below.	See below

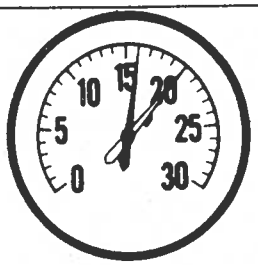


Normal engine

INDICATION: Normal engine in good condition

Proceed to: 8.1

Gauge reading: Steady, from 17–22 in./Hg.

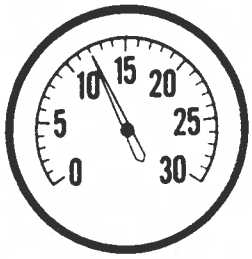


Sticking valves

INDICATION: Sticking valves or ignition miss

Proceed to: 9.1, 8.3

Gauge reading: Intermittent fluctuation at idle

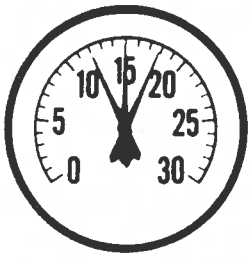


Incorrect valve timing

INDICATION: Late ignition or valve timing, low compression, stuck throttle valve, leaking carburetor or manifold gasket

Proceed to: 6.1

Gauge reading: Low (10–15 in./Hg) but steady

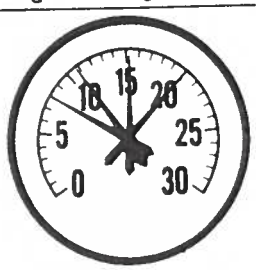


Carburetor requires adjustment

INDICATION: Improper carburetor adjustment or minor intake leak.

Proceed to: 7.2

Gauge reading: Drifting needle

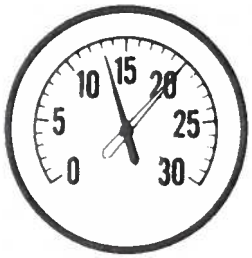


Blown head gasket

INDICATION: Ignition miss, blown cylinder head gasket, leaking valve or weak valve spring

Proceed to: 8.3, 6.1

Gauge reading: Needle fluctuates as engine speed increases

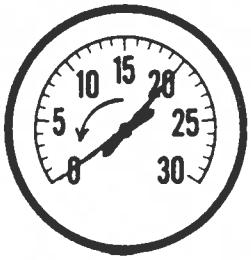


Burnt or leaking valves

INDICATION: Burnt valve or faulty valve clearance: Needle will fall when defective valve operates

Proceed to: 9.1

Gauge reading: Steady needle, but drops regularly

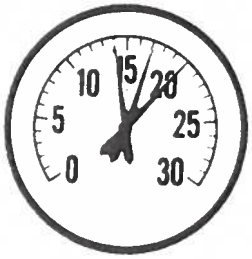


Clogged exhaust system

INDICATION: Choked muffler, excessive back pressure in system

Proceed to: 10.1

Gauge reading: Gradual drop in reading at idle



Worn valve guides

INDICATION: Worn valve guides

Proceed to: 9.1

Gauge reading: Needle vibrates excessively at idle, but steadies as engine speed increases

White pointer = steady gauge hand

Black pointer = fluctuating gauge hand

Test and Procedure	Results and Indications	Proceed To
7.2 Attach a vacuum gauge per 7.1, and test for an intake manifold leak. Squirt a small amount of oil around the intake manifold gaskets, carburetor gaskets, plugs and fittings. Observe the action of the vacuum gauge.	If the reading improves, replace the indicated gasket, or seal the indicated fitting or plug:	**8.1**
	If the reading remains low:	**7.3**
7.3 Test all vacuum hoses and accessories for leaks as described in 7.2. Also check the carburetor body (dashpots, automatic choke mechanism, throttle shafts) for leaks in the same manner.	If the reading improves, service or replace the offending part(s):	**8.1**
	If the reading remains low:	**6.1**

SECTION 8—SECONDARY ELECTRICAL SYSTEM

Test and Procedure	Results and Indications	Proceed to
8.1 Remove the distributor cap and check to make sure that the rotor turns when the engine is cranked. Visually inspect the distributor components.	Clean, tighten or replace any components which appear defective.	**8.2**
8.2 Connect a timing light (per manufacturer's recommendation) and check the dynamic ignition timing. Disconnect and plug the vacuum hose(s) to the distributor if specified, start the engine, and observe the timing marks at the specified engine speed.	If the timing is not correct, adjust to specifications by rotating the distributor in the engine: (Advance timing by rotating distributor opposite normal direction of rotor rotation, retard timing by rotating distributor in same direction as rotor rotation.)	**8.3**
8.3 Check the operation of the distributor advance mechanism(s): To test the mechanical advance, disconnect the vacuum lines from the distributor advance unit and observe the timing marks with a timing light as the engine speed is increased from idle. If the mark moves smoothly, without hesitation, it may be assumed that the mechanical advance is functioning properly. To test vacuum advance and or retard systems, alternately crimp and release the vacuum line, and observe the timing mark for movement. If movement is noted, the system is operating.	If the systems are functioning	**8.4**
	If the systems are not functioning, remove the distributor, and test on a distributor tester.	**8.4**
8.4 Locate an ignition miss: With the engine running, remove each spark plug wire, one at a time, until one is found that doesn't cause the engine to roughen and slow down. **CAUTION: Do not pull on the wire to remove the boot from the plug. Be sure your hand is insulated from the wire.**	When the missing cylinder is identified	**4.1**

SECTION 9—VALVE TRAIN

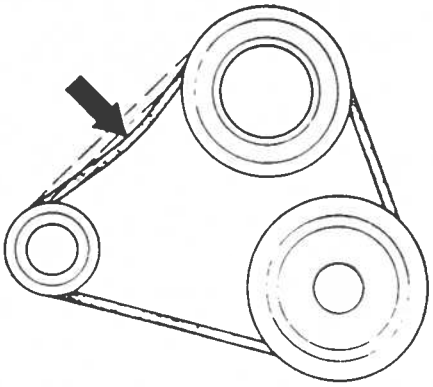
Test and Procedure	Results and Indications	Proceed to
9.1 Evaluate the valve train: Remove the valve cover, and ensure that the valves are adjusted to specifications. A mechanic's stethoscope may be used to aid in the diagnosis of the valve train. By pushing the probe on or near push rods or rockers, valve noise often can be isolated. A timing light also may be used to diagnose valve problems. Connect the light according to manufacturer's recommendations, and start the engine. Vary the firing moment of the light by increasing the engine speed (and therefore the ignition advance), and moving the trigger from cylinder to cylinder. Observe the movement of each valve.	Sticking valves or erratic valve train motion can be observed with the timing light. The cylinder head must be disassembled for repairs.	**See Car Section**
9.2 Check the valve timing: Locate top dead center of the No. 1 piston, and install a degree wheel or tape on the crankshaft pulley or damper with zero corresponding to an index mark on the engine. Rotate the crankshaft in its direction of rotation, and observe the opening of the No. 1 cylinder intake valve. The opening should correspond with the correct mark on the degree wheel according to specifications.	If the timing is not correct, the timing cover must be removed for further investigation.	**See Car Section**

SECTION 10—EXHAUST SYSTEM

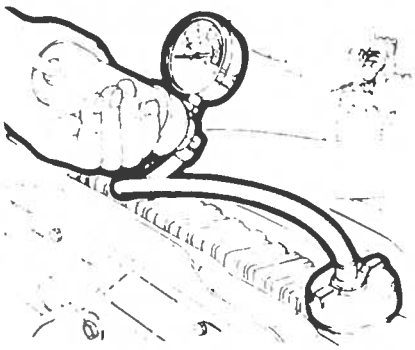
Test and Procedure	Results and Indications	Proceed to
10.1 Determine whether the exhaust manifold heat control valve is operating: Operate the valve by hand to determine whether it is free to move. If the valve is free, run the engine to operating temperature and observe the action of the valve, to ensure that it is opening.	If the valve sticks, spray it with a suitable solvent, open and close the valve to free it, and retest.	
	If the valve functions properly	**10.2**
	If the valve does not free, or does not operate, replace the valve.	**10.2**
10.2 Ensure that there are no exhaust restrictions: Visually inspect the exhaust system for kinks, dents, or crushing. Also note that gases are flowing freely from the tailpipe at all engine speeds, indicating no restriction in the muffler or resonator.	Replace any damaged portion of the system.	**11.1**

SECTION 11—COOLING SYSTEM

Test and Procedure	Results and Indications	Proceed to
11.1 Visually inspect the fan belt for glazing, cracks, and fraying, and replace if necessary. Tighten the belt so that the longest span has approximately ½" play at its mid-point under thumb pressure (see Maintenance Section).	Replace or tighten the fan belt as necessary.	11.2
11.2 Check the fluid level of the cooling system.	If full or slightly low, fill as necessary.	11.5
	If extremely low	11.3
11.3 Visually inspect the external portions of the cooling system (radiator, radiator hoses, thermostat elbow, water pump seals, heater hoses, etc.) for leaks. If none are found, pressurize the cooling system to 14–15 psi.	If cooling system holds the pressure	11.5
	If cooling system loses pressure rapidly, reinspect external parts of the system for leaks under pressure. If none are found, check dipstick for coolant in crankcase. If no coolant is present, but pressure loss continues	11.4
	If coolant is evident in crankcase, remove cylinder head(s), and check gasket(s). If gaskets are intact, block and cylinder head(s) should be checked for cracks or holes.	
	If the gasket(s) is blown, replace, and purge the crankcase of coolant.	12.6
	NOTE: Occasionally, due to atmospheric and driving conditions, condensation of water can occur in the crankcase. This causes the oil to appear milky white. To remedy, run the engine until hot, and change the oil and oil filter.	
11.4 Check for combustion leaks into the cooling system: Pressurize the cooling system as above. Start the engine, and observe the pressure gauge. If the needle fluctuates, remove each spark plug wire, one at a time, noting which cylinder(s) reduce or eliminate the fluctuation.	Cylinders which reduce or eliminate the fluctuation, when the spark plug wire is removed, are leaking into the cooling system. Replace the head gasket on the affected cylinder bank(s).	See Car Section

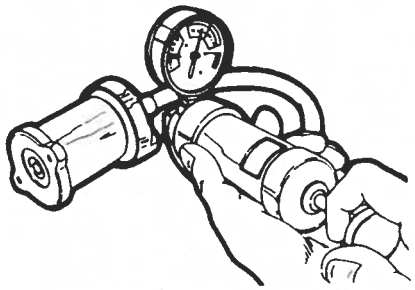


Checking belt tension



Pressurizing the cooling system

Test and Procedure	Results and Indications	Proceed To
11.5 Check the radiator pressure cap: Attach a radiator pressure tester to the radiator cap (wet the seal prior to installation). Quickly pump up the pressure, noting the point at which the cap releases.	If the cap releases within ±1 psi of the specified rating, it is operating properly.	11.6
	If the cap releases at more than ±1 psi of the specified rating, it should be replaced.	11.6



Checking radiator pressure cap

11.6 Test the thermostat: Start the engine cold, remove the radiator cap, and insert a thermometer into the radiator. Allow the engine to idle. After a short while, there will be a sudden, rapid increase in coolant temperature. The temperature at which this sharp rise stops is the thermostat opening temperature.	If the thermostat opens at or about the specified temperature	11.7
	If the temperature doesn't increase (If the temperature increases slowly and gradually, replace the thermostat.)	11.7
11.7 Check the water pump: Remove the thermostat elbow and the thermostat, disconnect the coil high tension lead (to prevent starting), and crank the engine momentarily.	If coolant flows, replace the thermostat and retest per 11 6.	11.6
	If coolant doesn't flow, reverse flush the cooling system to alleviate any blockage that might exist. If system is not blocked, and coolant will not flow, replace the water pump.	See Car Section

SECTION 12—LUBRICATION

Test and Procedure	Results and Indications	Proceed to
12.1 Check the oil pressure gauge or warning light: If the gauge shows low pressure, or the light is on for no obvious reason, remove the oil pressure sender. Install an accurate oil pressure gauge and run the engine momentarily.	If oil pressure builds normally, run engine for a few moments to determine that it is functioning normally, and replace the sender.	—
	If the pressure remains low	12.2
	If the pressure surges	12.3
	If the oil pressure is zero	12.3
12.2 Visually inspect the oil: If the oil is watery or very thin, milky, or foamy, replace the oil and oil filter.	If the oil is normal	12.3
	If after replacing oil the pressure remains low	12.3
	If after replacing oil the pressure becomes normal	—
12.3 Inspect the oil pressure relief valve and spring, to ensure that it is not sticking or stuck. Remove and thoroughly clean the valve, spring, and the valve body.	If the oil pressure improves	—
	If no improvement is noted	12.4

Test and Procedure		Results and Indications	Proceed To
12.4	Check to ensure that the oil pump is not cavitating (sucking air instead of oil): See that the crankcase is neither over nor underfull, and that the pickup in the sump is in the proper position and free from sludge.	Fill or drain the crankcase to the proper capacity, and clean the pickup screen in solvent if necessary. If no improvement is noted	12.5
12.5	Inspect the oil pump drive and the oil pump:	If the pump drive or the oil pump appear to be defective, service as necessary and retest per 12.1. If the pump drive and pump appear to be operating normally, the engine should be disassembled to determine where blockage exists.	12.1
12.6	Purge the engine of ethylene glycol coolant: Competely drain the crankcase and the oil filter. Obtain a commercial butyl cellosolve base solvent, designated for this purpose, and follow the instructions precisely. Following this, install a new oil filter and refill the crankcase with the proper weight oil. The next oil and filter change should follow shortly thereafter (1000 miles).		

Diesel Engine Troubleshooting

NOTE: The following troubleshooting procedures cover problems usually associated with diesel engines. Those problems common to both gasoline and diesel engines are covered in the gasoline engine troubleshooting procedures.

INDEX TO PROBLEMS

Problem/Symptom	Begin at Specific Diagnosis, Number
Fuel System	Section 1
Engine Starting Difficulty:	
Feed pump does not feed fuel	1.1
Injection pump does not feed fuel	1.2
Incorrect injection timing	1.3
Defective injection nozzles	1.4
Engine Operating Instability:	
Engine shuts off immediately after starting	1.5
Uneven idling	1.6
Engine will not reach maximum rated speed	1.7
Engine exceeds maximum rated speed	1.8
Loss of power	1.9
Engine Knock:	
Associated with exhaust gas problems	1.10
Not associated with exhaust gas problems	1.11
Engine Mechanical	Section 2
Engine Starting Difficulty	2.1
Unusual Noises	2.2
Engine Operating Instability	2.3
Loss of Power	2.4
Exhaust gas Problem	2.5
Engine Shut-Off	2.6
Loss of Oil Pressure	2.7
Oil Leakage	2.8
Compression Pressure Leakage	2.9

SECTION 1—Fuel System

Test and Procedure		Results and Indication	Proceed To
1.1a	Check for pressure at the outlet of the feed pump	If pressure exists, there is a clog in the supply line. Clean or replace it. If there is little or no pressure at the outlet, the filter is clogged. Clean or replace the filter. If the filter is clear, the feed pump piston is inoperative. Relace it.	1.1b
1.1b	Check the feed pump valves	If the inlet and outlet valves do not operate, the check valve or spring is broken. Replace it.	1.2a
1.2a	Check for fuel leakage at the overflow or return line	A clogged filter can result in high pressure causing leakage. Replace the filter.	1.2b
1.2b	Check for fuel in the filter leaking at the overflow valve	If leakage is found, the overflow valve is damaged. Replace it.	1.2c
1.2c	Check for leakage at the injection pump overflow valve	If leakage is found, it is caused by: damaged overflow valve, sticking plunger, or sticking delivery valve. Replace the defective part(s).	1.2d
1.2d	Check the injection pump plunger feed pressures.	If pressure at the plungers is low, replace the plunger(s).	1.2e

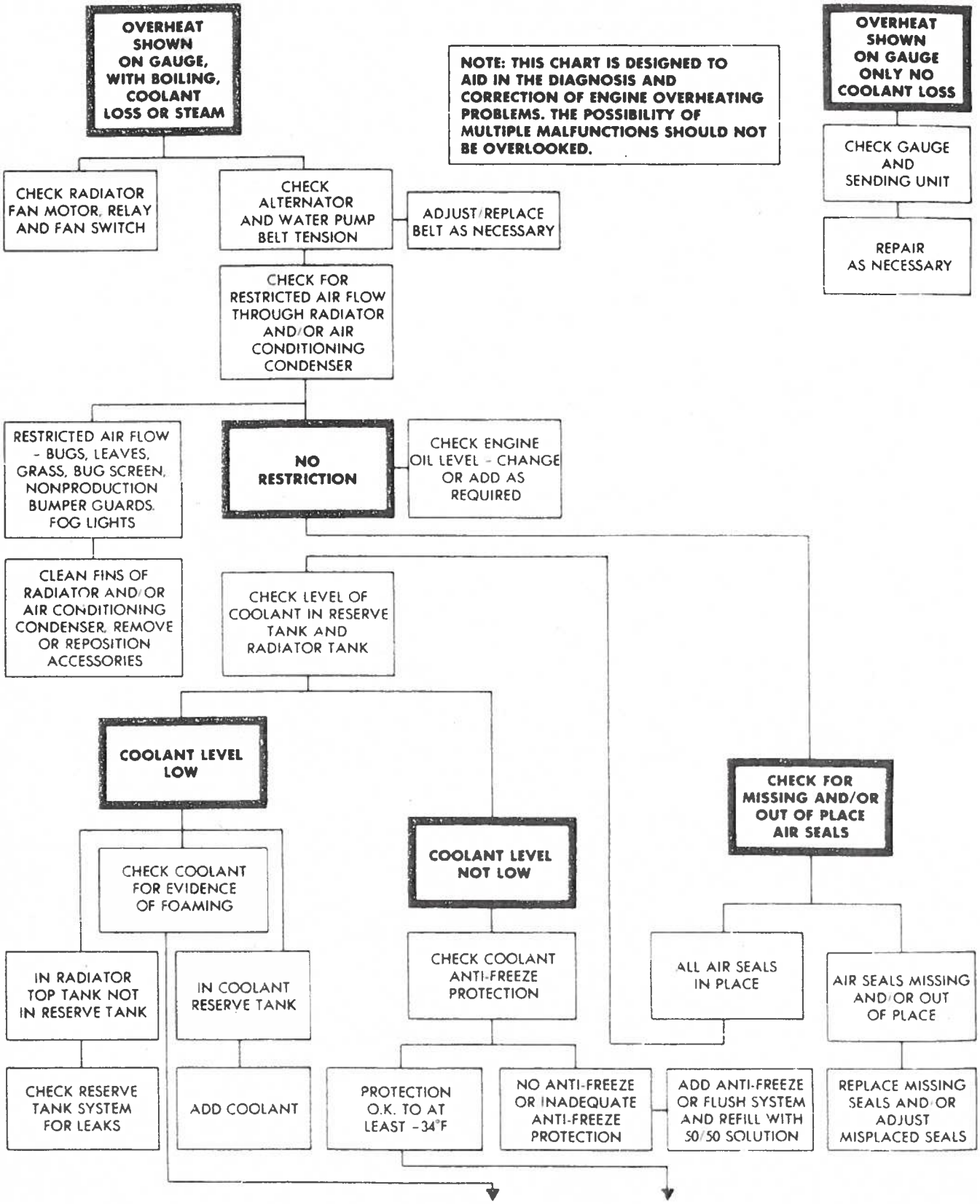
Test and Procedure		Results and Indication	Proceed To
1.2e	Check to make sure the injection pump is operating	An inoperative pump is caused by: a damaged or missing shaft key, or a damaged drive gear train.	1.3a
1.3a	Check that the pump timing marks are correctly aligned in the gear train	Incorrect timing marks alignment must be corrected.	1.3b
1.3b	Check that the injection pump is properly mounted	Remove and install the pump correctly	1.4a
1.4a	Install an injection nozzle on a tester and make sure that fuel is continuously ejected	A broken or intermittent stream is caused by a damaged spring or a sticking nozzle needle	1.4b
1.4b	With the nozzle on the tester as in 1.4a, check that shutoff is clean with no dribble or afterdrip	Dribble is caused by a defective nozzle valve seat. Replace the nozzle.	1.4c
1.4c	Using a tester, check injection pressure	Low pressure is a result of a weak spring. Replace the spring or adjust the initial injection pressure.	1.5a
1.5a	See 1.2a	Proceed as in 1.2a	1.5b
1.5b	Check for water in the fuel	Drain and clean the tank	1.5c
1.5c	Check for air in the fuel lines	Air can be introduced through a damaged fuel inlet line, a loose inlet line connector or a damaged gasket	1.5d
1.5d	Check for insufficient fuel feed	Insufficient fuel feed is caused by: a damaged feed pump, a clogged tank vent, or a clogged filter. Replace or repair as necessary.	1.6a
1.6a	Check the control rack action for smooth operation	Uneven control rack operation is caused by: a sticking plunger, improper meshing of the rack and pinion, poor seating of the plunger spring, insufficient clearance between the plunger and lower spring seat, or an overly tight delivery valve holder. Replace or adjust as necessary.	1.6b
1.6b	Check that the injection pump discharge is uniform	If the output is uneven, adjust as necessary	1.6c
1.6c	Check that the injection pump discharge volume is adequate	An inadequate discharge volume is caused by a worn plunger or a broken spring	1.6d
1.6d	Check for even low speed engine performance	If the engine performs unevenly or erratically at low speed only, a worn feed pump piston or defective feed pump valve is the cause.	1.6e
1.6e	Check for smooth engine operation throughout the operating range	This problem is usually caused by mechanical governor defects such as: a defective low speed spring, defective damper spring, or excessive friction among moving parts. Replace the defective parts.	1.6f
1.6f	Check the injectors on a tester	Improper nozzle operation should be corrected accordingly	1.7a
1.7a	Check the operating governor	A broken or weak spring in the governor will prevent full speed operation.	1.7b
1.7b	Check the injectors on a tester for a drop in injector output	A drop in output is caused by a sticking needle or a dirty nozzle. Replace or clean as necessary.	1.8a

Test and Procedure		Results and Indications	Proceed To
1.8a	Check the injection pump for proper rack and pinion action	A catching or dirty rack and pinion will cause overspeeding.	1.8b
1.8b	Check the governor adjustment	An improperly adjusted governor will cause overspeeding. Adjust.	1.9a
1.9a	Check the injection pump output	Low output can be caused by: Incorrect adjustment—Adjust Loose delivery valve—Tighten Broken delivery valve seal—Replace Poor valve seat contact—Replace Broken/weak delivery valve spring—Replace	1.9b
1.9b	Check for unusual noise at the injection pump	A noisy pump is an indication of a broken plunger spring	1.9c
1.9c	Check plunger operation	A sticking injection pump plunger will cause power loss. Replace.	1.9d
1.9d	Check the injection timer	A lag in injection timing is caused by large clearances in the timer due to wear. Replace.	1.9e
1.9e	Check for air or water in the fuel	Bleed the air or drain the fuel and clean the tank and lines	1.9f
1.9f	Check the injection timing	Readjust timing if necessary	1.10a
1.10a	Check the initial injection timing	Adjust if necessary	1.10b
1.10b	Check the injection pressure	High pressure will cause knock. Adjust as necessary	1.10c
1.10c	Check the injector nozzle	A clogged nozzle causes knock. Clean or replace the nozzle.	1.11a
1.11a	Check the injection pump output and timing	Excessive output, coupled with incorrect timing causes knock. Adjust as necessary	1.11b
1.11b	Check the delivery valve seat	Replace a defective seat	1.11c
1.11c	Check the pump plungers	Replace badly worn plungers	1.11d
1.11d	Check injector opening pressure on a tester	Adjust as necessary	1.11e
1.11e	Check the injector	Replace a broken nozzle spring or sticking needle.	

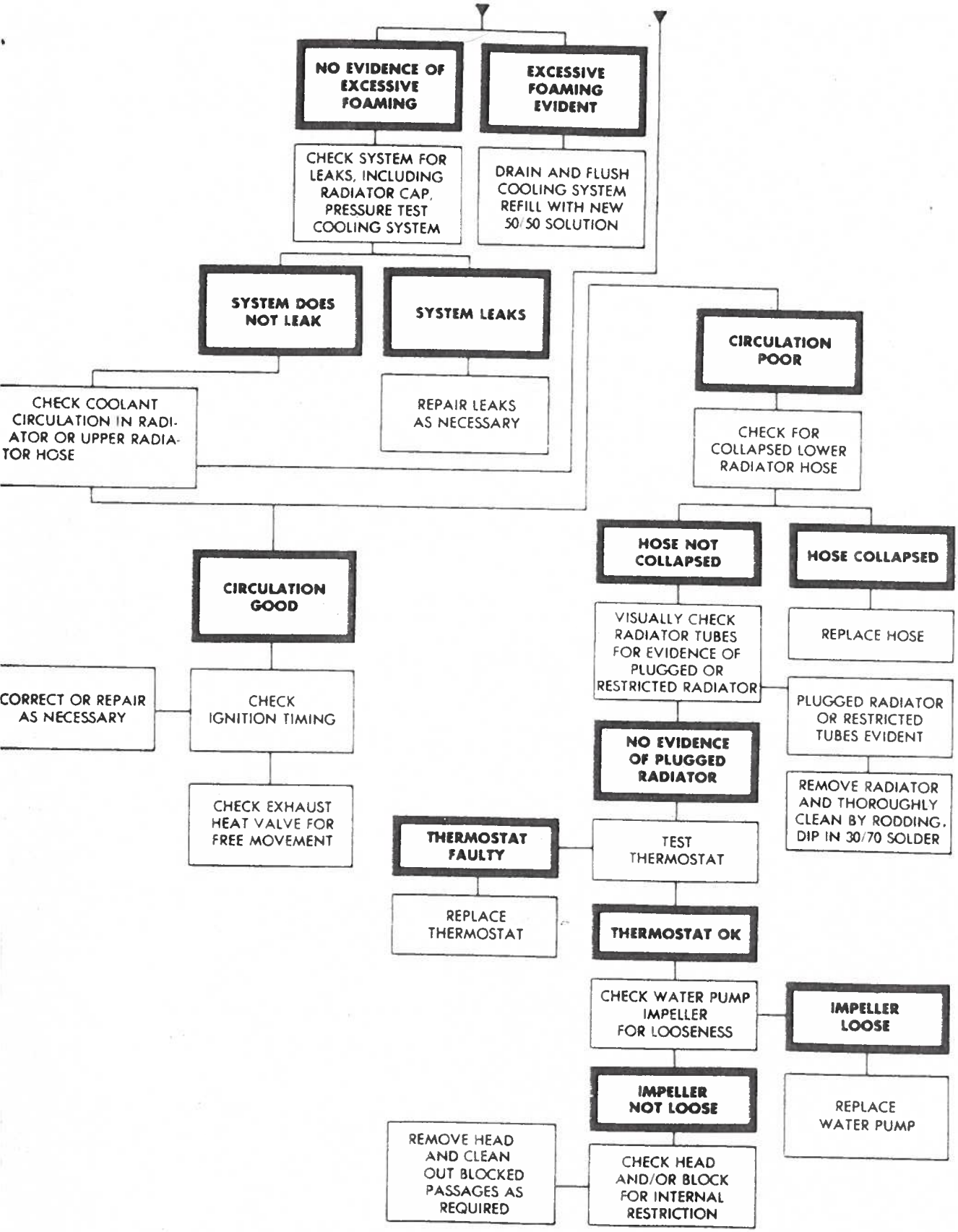
SECTION 2—ENGINE MECHANICAL

Test and Procedure		Results and Indications	Proceed To
2.1a	Check for piston seizing	Seized pistons are caused by low oil pressure, oil breakdown, or overheating. Replace the pistons and liners.	2.1b
2.1b	Check for a damaged flywheel ring gear	A damaged ring gear will cause poor meshing with the starter. Replace the ring gear.	2.1c
2.1c	Make a compression check	Low compression can be caused by: sticking rings, worn rings, worn liners. Replace the rings or liners.	2.2a
2.2a	A knocking noise at idle or during acceleration can be caused by a variety of wear problems.	Use a stethoscope or similar listening device to try to pinpoint the source of the noise. Among other reasons for knocking are: piston pins, rod bearings, loose rod caps, crankshaft journals and/or bearings, crankshaft thrust washer. Replace any worn parts.	2.2b
2.2b	An infrequently encountered noise is a continuous growl during acceleration	This problem is usually caused by problems in the engine timing gears. Poor contact, excessive backlash or loose gears are usually at fault.	2.2c
2.2c	Intermittent noises are the hardest to find. They are usually caused by broken moving parts.	Check the gear train for a chipped or cracked gear; the oil pan for broken parts or foreign objects or the cylinder head for a broken valve or valve spring.	2.3
2.3	Check for oil in the combustion chambers	Oil entering the combustion chambers will cause the engine to overspeed if the amount of oil is too great, or run unevenly. Check for broken or sticking rings, bad head gasket(s) or worn valve guides.	2.4
2.4	Check the compression	Low compression is the main cause of power loss. The main causes for low compression are: worn rings or liners, cracked valves, warped head or block, and bad head gasket.	2.5
2.5	A large amount of black exhaust is caused by low compression	See 2.4 above	2.6
2.6	If the engine stops suddenly during operation, the cause is usually sudden damage	Check the pistons, main bearings or rod bearings for lack of lubrication. A seized camshaft is also a result of low or no lubrication. Check the timing gears for damage.	2.7
2.7	Check for excessive clearance between the bearings and journals on both the mains and rod bearings. Check the oil pressure.	Replace as necessary. Replace the pump as necessary.	2.8
2.8	Aside from the usual leaking gasket problems, check the condition of the combustion chamber O-rings.	Replace as necessary	2.9
2.9	Compression leakage is usually caused by a seal defect between the head and the block	Check the head gasket; check for loose head bolts; check for head or block warpage. Replace or repair as necessary.	

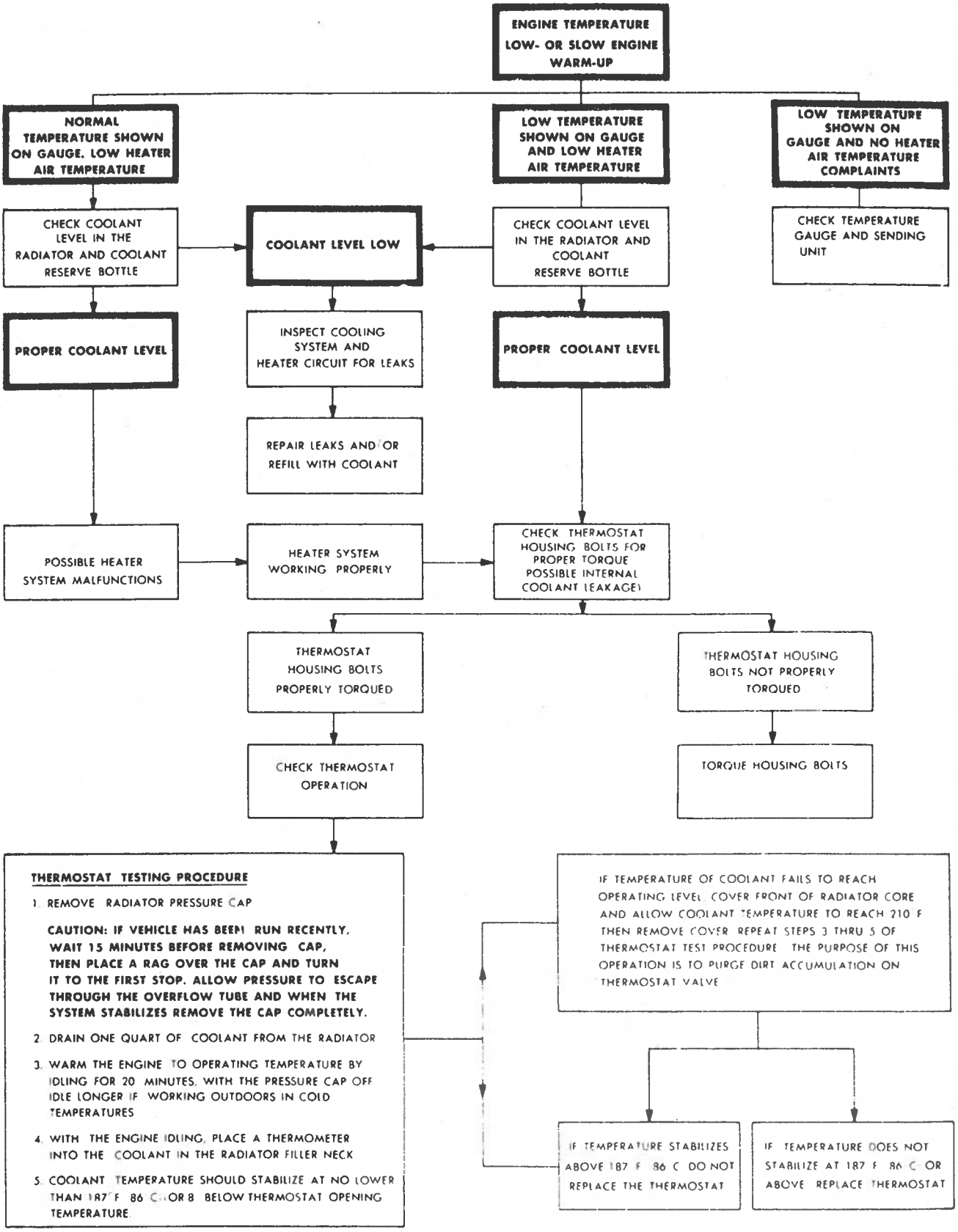
Engine Overheating Troubleshooting



Engine Overheating Troubleshooting



Low Engine Temperature Troubleshooting



DRIVELINE

Clutch System Troubleshooting

Condition	Possible Cause	Corrective Action
Clutch chatter	1. Grease on driven plate (disc) facing. 2. Binding clutch linkage. 3. Loose, damaged facings on driven plate (disc). 4. Engine mounts loose. 5. Incorrect height adjustment of pressure plate release levers. 6. Clutch housing or housing to transmission adapter misalignment. 7. Loose driven plate hub.	1. Replace plate. 2. Check for worn, bent, broken parts. Replace as required. Lube linkage. 3. Replace driven plate. 4. Tighten mounts. Replace if damaged. 5. Adjust release lever height. 6. Check bore and face run out. Correct as required. 7. Replace driven plate.
Clutch grabbing	1. Oil, grease on driven plate (disc) facing. 2. Broken pressure plate. 3. Warped or binding driven plate. Driven plate binding on clutch shaft.	1. Replace driven plate. 2. Replace pressure plate. 3. Replace warped driven plate. Replace clutch shaft if defective, scored, worn.
Clutch slips	1. Lack of lubrication in clutch linkage (linkage binds, causes incomplete engagement. 2. Incorrect pedal, or linkage adjustment. 3. Broken pressure plate springs. 4. Weak pressure plate springs. 5. Grease on driven plate facings (disc).	1. Lubricate linkage. 2. Adjust as required. 3. Replace pressure plate. 4. Replace pressure plate. 5. Replace driven plate.
Incomplete clutch release	1. Incorrect pedal or linkage adjustment or linkage binding. 2. Incorrect height adjustment on pressure plate release levers. 3. Loose, broken facings on driven plate (disc). 4. Bent, dished, warped driven plate caused by overheating.	1. Adjust as required. Lubricate linkage. 2. Adjust release lever height. 3. Replace driven plate. 4. Replace driven plate.
Grinding, whirring grating noise when pedal is depressed	1. Worn or defective throwout bearing. 2. Starter drive teeth contacting flywheel ring gear teeth.	1. Replace throwout bearing. 2. Look for milled or polished teeth on ring gear. Align clutch housing, replace starter drive or drive spring as required.
Squeal, howl, trumpeting noise when pedal is being released (occurs during first inch to inch and one-half of pedal travel)	1. Pilot bushing worn or lack of lubricant.	1. Replace worn bushing. If bushing appears OK, polish bushing with emery, soak lube wick in oil, lube bushing with oil, apply film of chassis grease to clutch shaft pilot hub, reassemble. **NOTE:** Bushing wear may be due to misalignment of clutch housing or housing to transmission adapter.
Vibration or clutch pedal pulsation with clutch disengaged (pedal fully depressed)	1. Worn or defective engine transmission mounts. 2. Flywheel run out, or damaged or defective clutch components.	1. Inspect and replace as required. 2. Replace components as required. (Flywheel run out at face not to exceed 0.005").

Manual Transmission Troubleshooting

Condition	Probable Cause
Jumping out of high gear	1. Misalignment of transmission case or clutch housing. 2. Worn pilot bearing in crankshaft. 3. Bent transmission shaft. 4. Worn high speed sliding gear. 5. Worn teeth in clutch shaft. 6. Insufficient spring tension on shifter rail plunger. 7. Bent or loose shifter fork. 8. End-play in clutch shaft. 9. Gears not engaging completely. 10. Loose or worn bearings on clutch shaft or mainshaft.
Sticking in high gear	1. Clutch not releasing fully. 2. Burred or battered teeth on clutch shaft. 3. Burred or battered transmission mainshaft. 4. Frozen synchronizing clutch. 5. Stuck shifter rail plunger. 6. Gearshift lever twisting and binding shifter rail. 7. Battered teeth on high speed sliding gear or on sleeve. 8. Lack of lubrication. 9. Improper lubrication. 10. Corroded transmission parts. 11. Defective mainshaft pilot bearing.
Jumping out of second gear	1. Insufficient spring tension on shifter rail plunger. 2. Bent or loose shifter fork. 3. Gears not engaging completely. 4. End-play in transmission mainshaft. 5. Loose transmission gear bearing. 6. Defective mainshaft pilot bearing. 7. Bent transmission shaft. 8. Worn teeth on second speed sliding gear or sleeve. 9. Loose or worn bearings on transmission mainshaft. 10. End-play in countershaft.
Sticking in second gear	1. Clutch not releasing fully. 2. Burred or battered teeth on sliding sleeve. 3. Burred or battered transmission mainshaft. 4. Frozen synchronizing clutch. 5. Stuck shifter rail plunger. 6. Gearshift lever twisting and binding shifter rail. 7. Lack of lubrication. 8. Second speed transmission gear bearings locked will give same effect as gears stuck in second. 9. Improper lubrication. 10. Corroded transmission parts.
Jumping out of low gear	1. Gears not engaging completely. 2. Bent or loose shifter fork. 3. End-play in transmission mainshaft. 4. End-play in countershaft. 5. Loose or worn bearings on transmission mainshaft. 6. Loose or worn bearings in countershaft. 7. Defective mainshaft pilot bearing.
Sticking in low gear	1. Clutch not releasing fully. 2. Burred or battered transmission mainshaft. 3. Stuck shifter rail plunger. 4. Gearshift lever twisting and binding shifter rail. 5. Lack of lubrication. 6. Improper lubrication. 7. Corroded transmission parts.

Condition	Probable Cause
Jumping out of reverse gear	1. Insufficient spring tension on shifter rail plunger. 2. Bent or loose shifter fork. 3. Badly worn gear teeth. 4. Gears not engaging completely. 5. End-play in transmission mainshaft. 6. Idler gear bushings loose or worn. 7. Loose or worn bearings on transmission mainshaft. 8. Defective mainshaft pilot bearing.
Sticking in reverse gear	1. Clutch not releasing fully. 2. Burred or battered transmission mainshaft. 3. Stuck shifter rail plunger. 4. Gearshift lever twisting and binding shifter rail. 5. Lack of lubrication. 6. Improper lubrication. 7. Corroded transmission parts.
Failure of gears to synchronize	1. Binding pilot bearing on mainshaft, will synchronize in high gear only. 2. Clutch not releasing fully. 3. Detent spring weak or broken. 4. Weak or broken springs under balls in sliding gear sleeve. 5. Binding bearing on clutch shaft. 6. Binding countershaft. 7. Binding pilot bearing in crankshaft 8. Badly worn gear teeth. 9. Scored or worn cones. 10. Improper lubrication. 11. Constant mesh gear not turning freely on transmission mainshaft. Will synchronize in that gear only.
Gears spinning when shifting into gear from neutral	1. Clutch not releasing fully. 2. In some cases an extremely light lubricant in transmission will cause gears to continue to spin for a short time after clutch is released. 3. Binding pilot bearing in crankshaft.
Noisy in all gears	1. Insufficient lubricant. 2. Worn countergear bearings. 3. Worn or damaged main drive gear or countergear. 4. Damaged main drive gear or mainshaft bearings. 5. Worn or damaged countergear anti-lash plate.
Noisy in high gear	1. Damaged main drive gear bearing. 2. Damaged mainshaft bearing. 3. Damaged high speed gear synchronizer.
Noisy in neutral	1. Damaged main drive gear bearing. 2. Damaged or loose mainshaft pilot bearing. 3. Worn or damaged countergear anti-lash plate. 4. Worn countergear bearings.
Noisy in all reduction gears	1. Insufficient lubricant. 2. Worn or damaged drive gear or countergear.
Noisy in second only	1. Damaged or worn second gear constant mesh gears. 2. Worn or damaged countergear rear bearings. 3. Damaged or worn second gear synchronizer.
Noisy in second only	1. Damaged or worn second gear constant mesh gears. 2. Worn or damaged countergear rear bearings. 3. Damaged or worn second gear synchronizer.
Noisy in third only (four speed)	1. Damaged or worn third gear constant mesh gears. 2. Worn or damaged countergear bearings.

Condition	Probable Cause
Noisy in reverse only	1. Worn or damaged reverse idler gear or idler bushing. 2. Worn or damaged mainshaft reverse gear. 3. Worn or damaged reverse countergear. 4. Damaged shift mechanism.
Excessive backlash in all reduction gears	1. Worn countergear bearings. 2. Excessive end–play in countergear.

Automatic Transmission Troubleshooting

Keeping alert to changes in the operating characteristics of the transmission (changing shift points, noises, etc.) can prevent small problems from becoming large ones. If the problem cannot be traced to loose bolts, fluid level, misadjusted linkage, clogged filters or similar problems, you should probably seek professional service.

TRANSMISSION FLUID INDICATIONS

The appearance and odor of the transmission fluid can give valuable clues to the overall condition of the transmission. Always note the appearance of the fluid when you check the fluid level or change the fluid. Rub a small amount of fluid between your fingers to feel for grit and smell the fluid on the dipstick.

If The Fluid Appears	It Indicates
Clear and red colored	Normal operation
Discolored (extremely dark red or brownish) or smells burned	Band or clutch pack failure, usually caused by an overheated transmission. Hauling very heavy loads with insufficient power or failure to change the fluid often results in overheating. Do not confuse this appearance with newer fluids that have a darker red color and a strong odor (though not a burned odor).
Foamy or aerated (light in color and full of bubbles)	The level is too high (gear train is churning oil) An internal air leak (air is mixing with the fluid). Have the transmission checked professionally.
Solid residue in the fluid	Defective bands, clutch pack or bearings. Bits of band material or metal abrasives are clinging to the dipstick. Have the transmission checked professionally.
Varnish coating on the dipstick	The transmission fluid is overheating

Problem	Possible Cause	Correction
Slow initial engagement	1. Improper fluid level. 2. Damaged or improperly adjusted linkage. 3. Contaminated fluid. 4. Faulty clutch and band application, or oil control pressure system.	1. Add fluid as required. 2. Repair or adjust linkage. 3. Perform fluid level check. 4. Perform control pressure test.
Rough initial engagement in either forward or reverse	1. Improper fluid level. 2. High engine idle. 3. Looseness in the driveshaft, U-joints or engine mounts. 4. Incorrect linkage adjustment. 5. Faulty clutch or band application, or oil control pressure system. 6. Sticking or dirty valve body.	1. Perform fluid level check. 2. Adjust idle to specifications. 3. Repair as required. 4. Repair or adjust linkage. 5. Perform control pressure test. 6. Clean, repair or replace valve body.

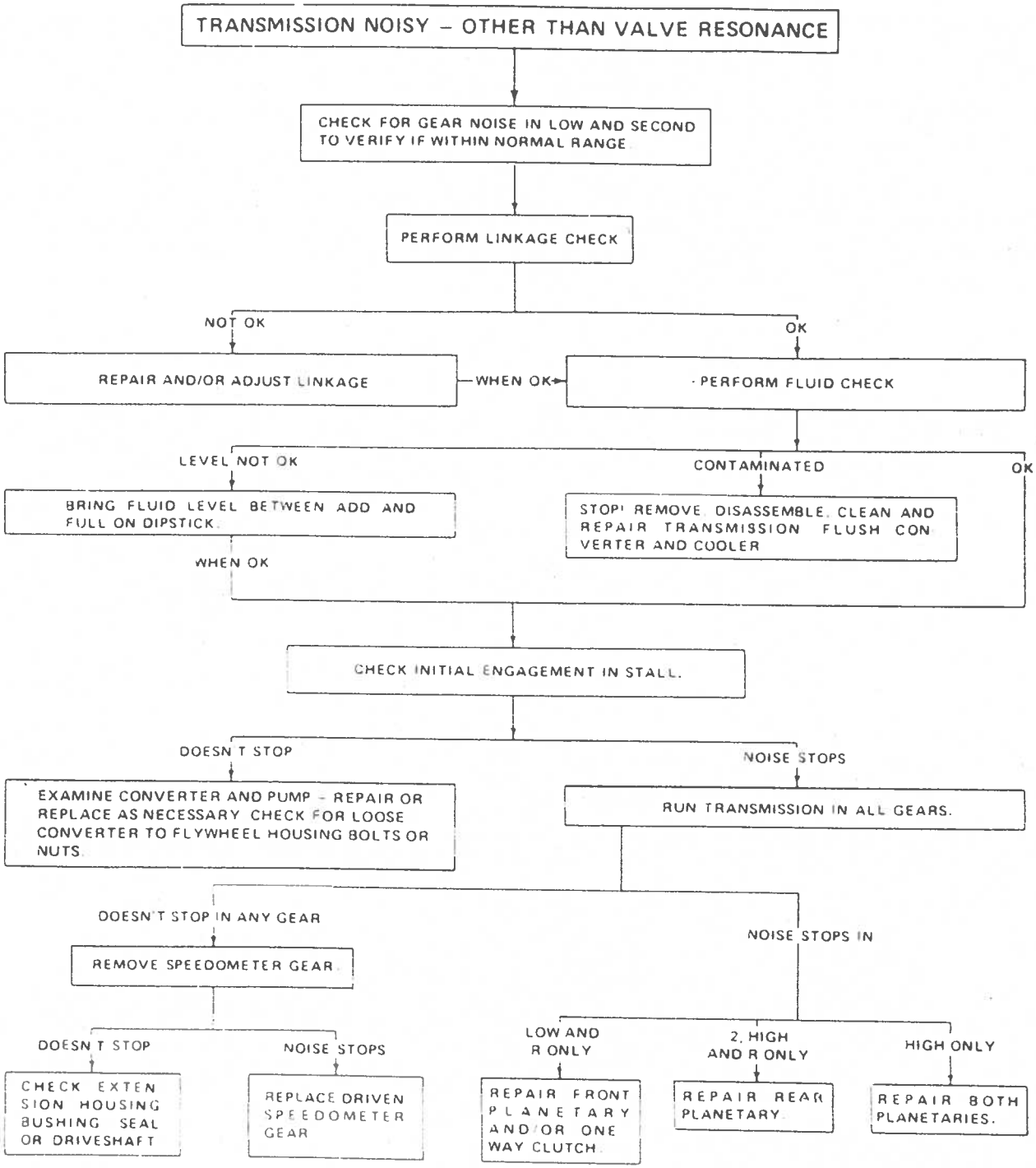
Problem	Possible Cause	Correction
No drive, slips or chatters in first gear in D. All other gears normal.	1. Faulty one-way clutch.	1. Repair or replace one-way clutch.
No drive, slips or chatters in second gear.	1. Improper fluid level. 2. Damaged or improperly adjusted linkage. 3. Intermediate band out of adjustment. 4. Faulty band or clutch application, or oil pressure control system. 5. Faulty servo and/or internal leaks. 6. Dirty or sticking valve body. 7. Polished, glazed intermediate band or drum.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Adjust intermediate band. 4. Perform control pressure test. 5. Perform air pressure test. 6. Clean, repair or replace valve body. 7. Replace or repair as required.
No drive in any gear.	1. Improper fluid level. 2. Damaged or improperly adjusted linkage. 3. Faulty clutch or band application, or oil control pressure system. 4. Internal leakage. 5. Valve body loose. 6. Faulty clutches. 7. Sticking or dirty valve body.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Perform control pressure test. 4. Check and repair as required. 5. Tighten to specification. 6. Perform air pressure test. 7. Clean, repair or replace valve body.
No drive forward—reverse OK.	1. Improper fluid level 2. Damaged or improperly adjusted linkage. 3. Faulty clutch or band application, or oil pressure control system. 4. Faulty forward clutch or governor. 5. Valve body loose 6. Dirty or sticking valve body.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Perform control pressure test. 4. Perform air pressure test. 5. Tighten to specification. 6. Clean, repair or replace valve body.
No drive, slips or chatters in reverse—forward OK.	1. Improper fluid level 2. Damaged or improperly adjusted linkage. 3. Looseness in the drivehsaft, U-joints or engine mounts. 4. Bands or clutches out of adjustment. 5. Faulty oil pressure control system. 6. Faulty reverse clutch or servo. 7. Valve body loose. 8. Dirty or sticking valve body.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Repair as required. 4. Adjust as necessary. 5. Perform control pressure test. 6. Perform air pressure test. 7. Tighten to specifications. 8. Clean, repair or replace valve body.
Starts in high—in D drag or lockup at 1-2 shift point or in 2 or 1.	1. Improper fluid level. 2. Damaged or improperly adjusted linkage. 3. Faulty governor. 4. Faulty clutches and/or internal leaks. 5. Valve body loose. 6. Dirty, sticking valve body. 7. Poor mating of valve body to case mounting surfaces.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Repair or replace governor, clean screen. 4. Perform air pressure test. 5. Tighten to specifications. 6. Clean, repair or replace valve body. 7. Replace valve body or case.

Problem	Possible Cause	Correction
Starts up in 2nd or 3rd but no lockup at 1-2 shift points.	1. Improper fluid level. 2. Damaged or improperly adjusted linkage. 3. Improper band and/or clutch application, or oil pressure control system. 4. Faulty governor. 5. Valve body loose. 6. Dirty or sticking valve body. 7. Cross leaks between valve body and case mating surface.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Perform control pressure test. 4. Perform governor check. Replace or repair governor, clean screen. 5. Tighten to specification. 6. Clean, repair or replace valve body. 7. Replace valve body and/or case as required.
Shift points incorrect.	1. Improper fluid level. 2. Improper vacuum hose routing or leaks. 3. Improper operation of EGR system. 4. Linkage out of adjustment. 5. Improper speedometer gear installed. 6. Improper clutch or band application, or oil pressure control system. 7. Faulty governor. 8. Dirty or sticking valve body.	1. Perform fluid level check. 2. Correct hose routing. 3. Repair or replace as required. 4. Repair or adjust linkage. 5. Replace gear. 6. Perform shift test and control pressure test. 7. Repair or replace governor—clean screen. 8. Clean, repair or replace valve body.
No upshift at any speed in D.	1. Improper fluid level. 2. Vacuum leak to diaphragm unit. 3. Linkage out of adjustment. 4. Improper band or clutch application, or oil pressure control system. 5. Faulty governor. 6. Dirty or sticking valve bdy.	1. Perform fluid level check. 2. Repair vacuum line or hose. 3. Repair or adjust linkage. 4. Perform control pressure test. 5. Repair or replace governor, clean screen. 6. Clean, repair or replace valve body.
Shifts 1-3 in D.	1. Improper fluid level. 2. Intermediate band out of adjustment. 3. Faulty front servo and/or internal leaks. 4. Polished, glazed band or drum. 5. Improper band or clutch application, or oil pressure control system. 6. Dirty or sticking valve body.	1. Perform fluid level check. 2. Adjust band. 3. Perform air pressure test. Repair front servo and/or internal leaks. 4. Repair or replace band or drum. 5. Perform control pressure test. 6. Clean, repair or replace valve body.
Engine over-speeds on 2-3 shift.	1. Improper fluid level. 2. Linkage out of adjustment. 3. Improper band or clutch application, or oil pressure control system. 4. Faulty high clutch and/or intermediate servo. 5. Dirty or sticking valve body.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Perform control pressure test. 4. Perform air pressure test. Repair as required. 5. Clean repair or replace valve body.
Mushy 1-2 shift.	1. Improper fluid level 2. Incorrect engine idle and/or performance. 3. Improper linkage adjustment. 4. Intermediate band out of adjustment.	1. Perform fluid level check. 2. Tune, adjust engine idle as required. 3. Repair or adjust linkage. 4. Adjust intermediate band. 5. Perform control pressure test.

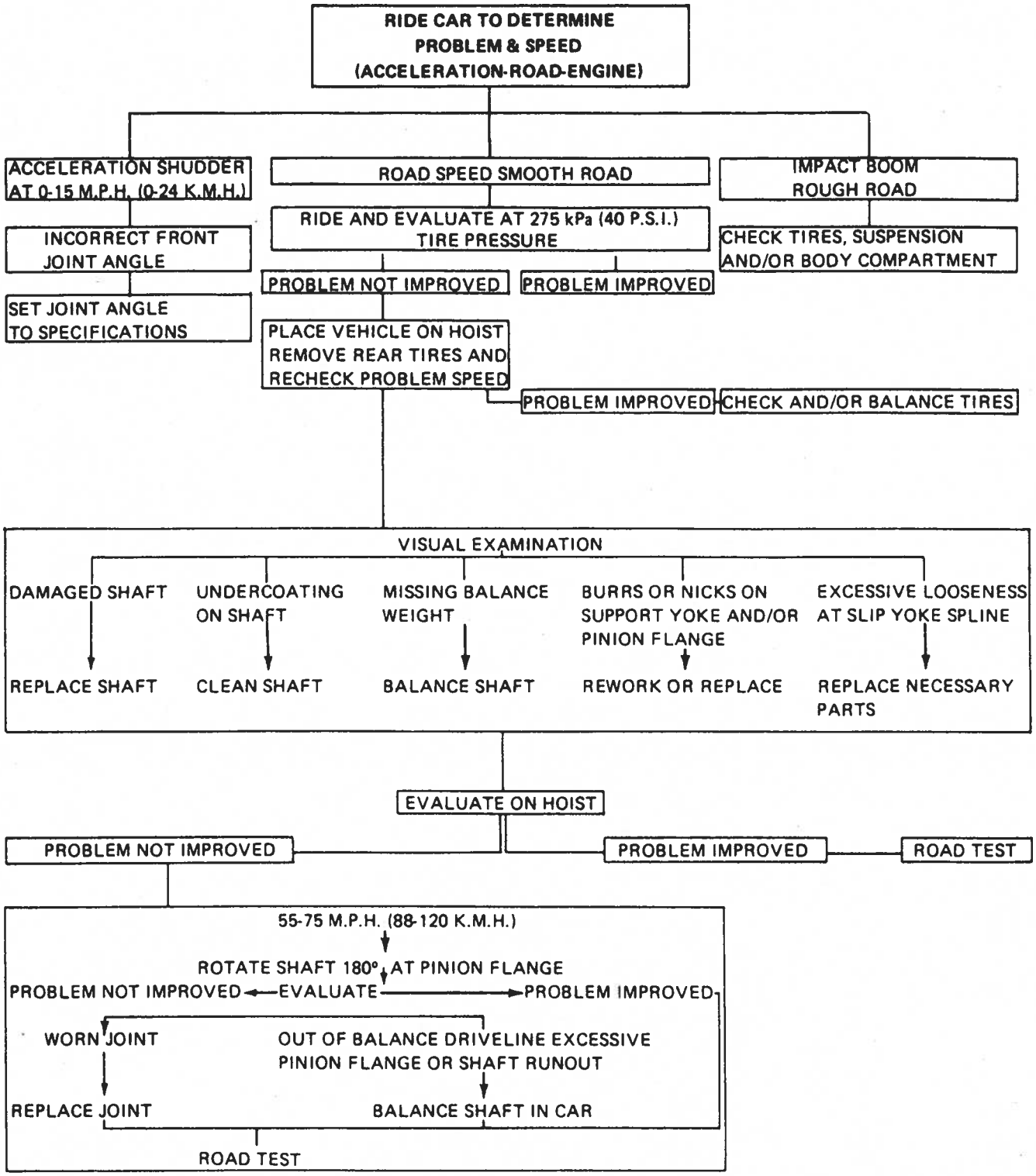
Problem	Possible Cause	Correction
Mushy 1-2 shift.	5. Improper band or clutch application, or oil pressure control system. 6. Faulty high clutch and/or intermediate servo release. 7. Polished, glazed band or drum. 8. Dirty or sticking valve body.	6. Perform air pressure test. Repair as required. 7. Repair or replace as required. 8. Clean, repair or replace valve body.
Rough 1-2 shift.	1. Improper fluid level. 2. Incorrect engine idle or performance. 3. Intermediate band out of adjustment. 4. Improper band or clutch application, or oil pressure control system. 5. Faulty intermediate servo. 6. Dirty or sticking valve body.	1. Perform fluid level check. 2. Tune, and adjust engine idle. 3. Adjust intermediate band. 4. Perform control pressure test. 5. Air pressure check intermediate servo. 6. Clean, repair or replace valve body.
Rough 2-3 shift	1. Improper fluid level. 2. Incorrect engine idle or performance. 3. Improper band or clutch application, or oil control pressure system. 4. Faulty intermediate servo apply and release and high clutch piston check ball. 5. Dirty or sticking valve body.	1. Perform fluid level check. 2. Tune and adjust engine idle. 3. Perform control pressure test. 4. Air pressure test the intermediate servo apply and release and the high clutch piston check ball. Repair as required. 5. Clean, repair or replace valve body.
Rough 3-1 shift at closed throttle in D.	1. Improper fluid level. 2. Incorrect engine idle or performance. 3. Improper linkage adjustment. 4. Improper clutch or band application or oil pressure control system. 5. Faulty governor operation. 6. Dirty or sticking valve body.	1. Perform fluid level check. 2. Tune, and adjust engine idle. 3. Repair or adjust linkage. 4. Perform control pressure test. 5. Perform governor test. Repair as required. 6. Clean, repair or replace valve body.
No forced downshifts.	1. Improper fluid level. 2. Linkage out of adjustment. 3. Improper clutch or band application, or oil pressure control system. 4. Faulty internal kickdown linkage. 5. Dirty or sticking valve body.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Perform control pressure test. 4. Repair internal kickdown linkage. 5. Clean, repair or replace valve body.
No 3-1 shift in D.	1. Improper fluid level. 2. Incorrect engine idle, or performance. 3. Faulty governor. 4. Dirty or sticking valve body.	1. Perform fluid level check. 2. Tune, and adjust engine idle. 3. Perform govenor check. Repair as required. 4. Clean, repair or replace valve body.
Runaway engine on 3-2 downshift.	1. Improper fluid level. 2. Linkage out of adjustment. 3. Intermediate band out of adjustment. 4. Improper band or clutch application, or oil pressure control system.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Adjust intermediate band. 4. Perform control pressure test. 5. Air pressure test check the intermediate servo. Repair servo and/or seals.

Problem	Possible Cause	Correction
Runaway engine on 3-2 downshift.	5. Faulty intermediate servo. 6. Polished, glazed band or drum. 7. Dirty or sticking valve body.	6. Repair or replace as required. 7. Clean, repair or replace valve body.
No engine braking in manual first gear.	1. Improper fluid level. 2. Linkage out of adjustment. 3. Bands or clutches out of adjustment. 4. Faulty oil pressure control system. 5. Faulty reverse servo. 6. Polished, glazed band or drum.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Adjust as necessary. 4. Perform control pressure test. 5. Perform air pressure test of reverse servo. Repair reverse clutch or rear servo as required. 6. Repair or replace as required.
No engine braking in manual second gear.	1. Improper fluid level. 2. Linkage out of adjustment. 3. Intermediate band out of adjustment. 4. Improper band or clutch application, or oil pressure control system. 5. Intermediate servo leaking. 6. Polished or glazed band or drum.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Adjust intermediate band. 4. Perform control pressure test. 5. Perform air pressure test of intermediate servo for leakage. Repair as required. 6. Repair or replace as required.
Transmission noisy—valve resonance.	1. Improper fluid level. 2. Linkage out of adjustment. 3. Improper band or clutch application, or oil pressure control system. 4. Cooler lines grounding. 5. Dirty sticking valve body. 6. Internal leakage or pump cavitation.	1. Perform fluid level check. 2. Repair or adjust linkage. 3. Perform control pressure test. 4. Free up cooler lines. 5. Clean, repair or replace valve body. 6. Repair as required.
Transmission overheats.	1. Improper fluid level. 2. Incorrect engine idle, or performance. 3. Improper clutch or band application, or oil pressure control system. 4. Restriction in cooler or lines. 5. Seized one-way clutch. 6. Dirty or sticking valve body.	1. Perform fluid level check. 2. Tune, or adjust engine idle. 3. Perform control pressure test. 4. Repair restriction. 5. Replace one-way clutch. 6. Clean, repair or replace valve body.
Transmission fluid leaks.	1. Improper fluid level. 2. Leakage at gasket, seals, etc. 3. Vacuum diaphragm unit leaking.	1. Perform fluid level check. 2. Remove all traces of lube on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and inspect for leakage. Repair as required. 3. Replace diaphragm.

Automatic Transmission Troubleshooting



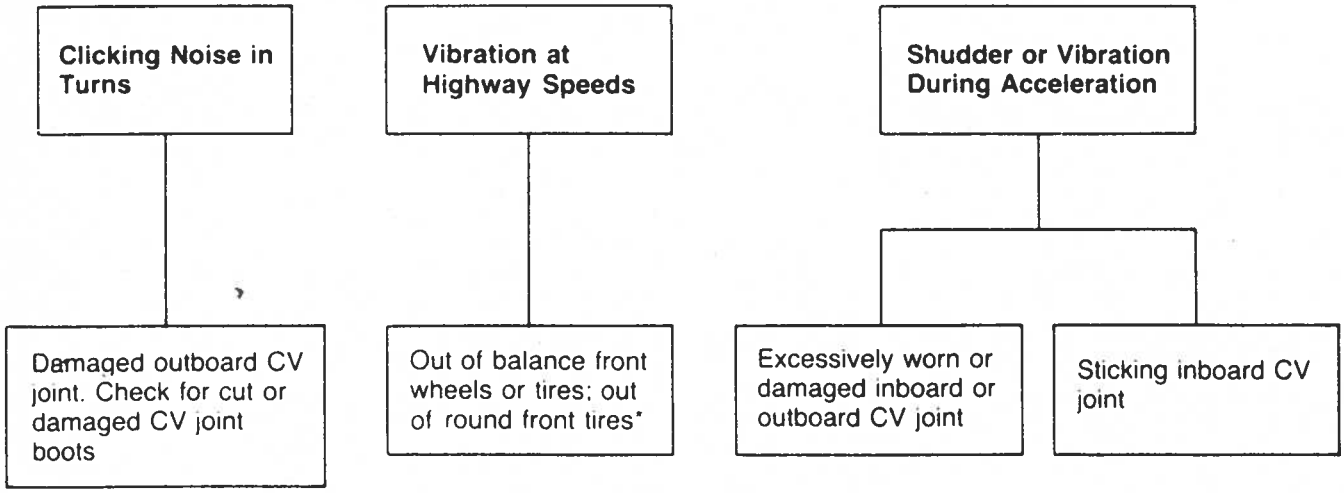
Driveshaft Troubleshooting
Vibration, Roughness, Rumble and/or Boom



Universal Joint Troubleshooting

Problem	Possible Cause	Correction
Leak at front slip yoke. **NOTE:** An occasional drop of lubricant leaking from splined yoke is normal and requires no attention.	1. Rough outside surface on splined yoke. 2. Defective transmission rear oil seal.	1. Replace seal if cut by burrs on yoke. Minor burrs can be smoothed by careful use of crocus cloth or honing with a fine stone. Replace yoke if outside surface is rough or burred badly. 2. Replace transmission rear oil seal. 3. Bring transmission oil up to proper level after correction.
Knock in drive line, clunking noise when car is operated under floating condition at 10 mph in high gear or neutral.	1. Worn or damaged universal joints. 2. Side gear hub counterbore in differential worn oversize.	1. Disassemble universal joints, inspect and replace worn or damaged parts. 2. Replace differential case and/or side gears as required.
Ping, snap or click in drive line. **NOTE:** Usually occurs on initial load application after transmission has been put into gear, either forward or reverse.	1. Loose upper or lower control arm bushing bolts. 2. Loose companion flange.	1. Tighten bolts to specified torque. 2. Remove companion flange, turn 180° from its original position, apply white lead to splines and reinstall. Tighten pinion nut to specified torque.

Front Wheel Drive Halfshaft Troubleshooting



*Halfshafts do not usually contribute to rotational vibrations.

Drive Axle Troubleshooting

Condition	Possible Cause	Correction
Rear wheel noise	1. Loose wheel. 2. Spalled wheel bearing cup or cone. 3. Defective or brinelled wheel bearing. 4. Excessive axle shaft endplay. 5. Bent or sprng axle shaft flange.	1. Tighten loose wheel nuts. 2. Check rear wheel bearings. If spalled or worn, replace. 3. Defective or brinelled bearings must be replaced. Check rear axle shaft end play. 4. Readjust axle shaft end play. 5. Replace bent or sprung axle shaft.
Scoring of differential gears and pinions	1. Insufficient lubrication. 2. Improper grade of lubricant. 3. Excessive spinning of one wheel.	1. Replace scored gears. Scoring marks on the pressure face of gear teeth or in the bore are caused by instantaneous fusing of the mating surfaces. Scored gears should be replaced. Fill rear axle to required capacity with proper lubricant. 2. Replace scored gears. Inspect all gears and bearings for possible damage. Clean and refill axle to required capacity with proper lubricant. 3. Replace scored gears. Inspect all gears, pinion bores and shaft for scoring, or bearings for possible damage.
Tooth breakage (ring gear and pinion)	1. Overloading. 2. Erratic clutch operation. 3. Ice-spotted pavements. 4. Improper adjustments.	1. Replace gear. Examine other gears and bearings for possible damage. Avoid future overloading. 2. Replace gear, and examine remaining parts for possible damage. Avoid erratic clutch operation. 3. Replace gears. Examine remaining parts for possible damage. Replace parts as required. 4. Replace gears. Examine other parts for possible damage. Be sure ring gear and pinion backlash is correct.
Rear axle noise	1. Insufficient lubricant. 2. Improper ring gear and pinion adjustment. 3. Unmatched ring gear and pinion. 4. Worn teeth on ring gear or pinion. 5. End-play in drive pinion bearings. 6. Side play in differential bearings. 7. Incorrect drive gearlash. 8. Limited-slip differential—moan and chatter.	1. Refill rear axle with correct amount of the proper lubricant. Also check for leaks and correct as necessary. 2. Check ring gear and pinion tooth contact. 3. Remove unmatched ring gear and pinion. Replace with a new matched gear and pinion set. 4. Check teeth on ring gear and pinion for contact. If necessary, replace with new matched set. 5. Adjust drive pinion bearing preload.

Problem	Possible Cause	Correction
Rear axle noise		6. Adjust differential bearing preload. 7. Correct drive gear lash. 8. Drain and flush lubricant. Refill with proper lubricant.
Loss of lubricant	1. Lubricant level too high. 2. Worn axle shaft oil seals. 3. Cracked rear axle housing. 4. Worn drive pinion oil seal. 5. Scored and worn companion flange. 6. Clogged vent. 7. Loose carrier housing bolts or housing cover screws.	1. Drain excess lubricant. 2. Replace worn oil seals with new ones. Prepare new seals before replacement. 3. Repair or replace housing as required. 4. Replace worn drive pinion oil seal with a new one. 5. Replace worn or scored companion flange and oil seal. 6. Remove obstructions. 7. Tighten bolts or cover screws to specifications and fill to correct level with proper lubricant.
Overheating of unit	1. Lubricant level too low. 2. Incorrect grade of lubricant. 3. Bearing adjusted too tightly. 4. Excessive wear in gears. 5. Insufficient ring gear-to-pinion clearance.	1. Refill rear axle. 2. Drain, flush and refill rear axle with correct amount of the proper lubricant. 3. Readjust bearings. 4. Check gears for excessive wear or scoring. Replace as necessary. 5. Readjust ring gear and pinion backlash and check gears for possible scoring.

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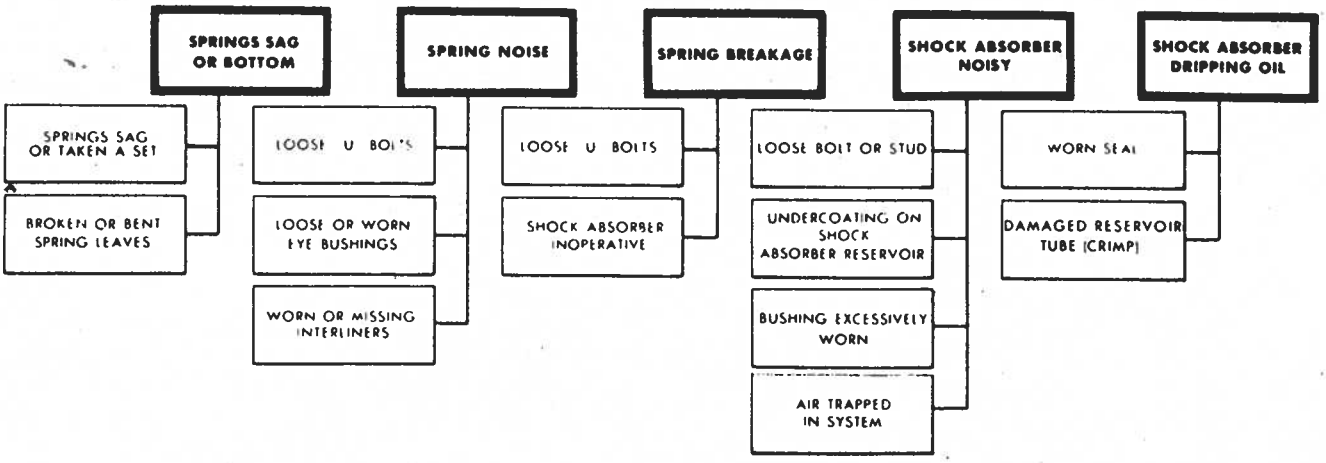
Shock Absorber and Rear Spring Troubleshooting



Front Suspension and Steering Linkage Troubleshooting—Rear Wheel Drive

FRONT END NOISE
- LOOSE OR WORN FRONT WHEEL BEARINGS
- LOOSE OR WORN SHOCK ABSORBER MOUNTING OR SHOCK ABSORBER
- LOOSE STEERING GEAR TO FRAME MOUNTING BOLTS
- STEERING KNUCKLE ARM CONTACTING THE LOWER CONTROL ARM WHEEL STOP
- WORN UPPER CONTROL ARM BUSHINGS
- WORN LOWER CONTROL ARM SHAFT BUSHINGS
- LOOSE OR WORN STRUT BUSHINGS
- LOOSE STRUTS OR LOWER CONTROL ARM
- BALL JOINTS REQUIRE LUBRICATION

EXCESSIVE PLAY IN STEERING
- LOOSE OR WORN FRONT WHEEL BEARINGS
- LOOSE OR WORN STEERING SHAFT COUPLING
- LOOSE STEERING GEAR TO FRAME MOUNTING BOLTS
- WORN TIE ROD ENDS
- WORN IDLER ARM BUSHING
- WORN STEERING GEAR PARTS
- INCORRECT STEERING GEAR ADJUSTMENT

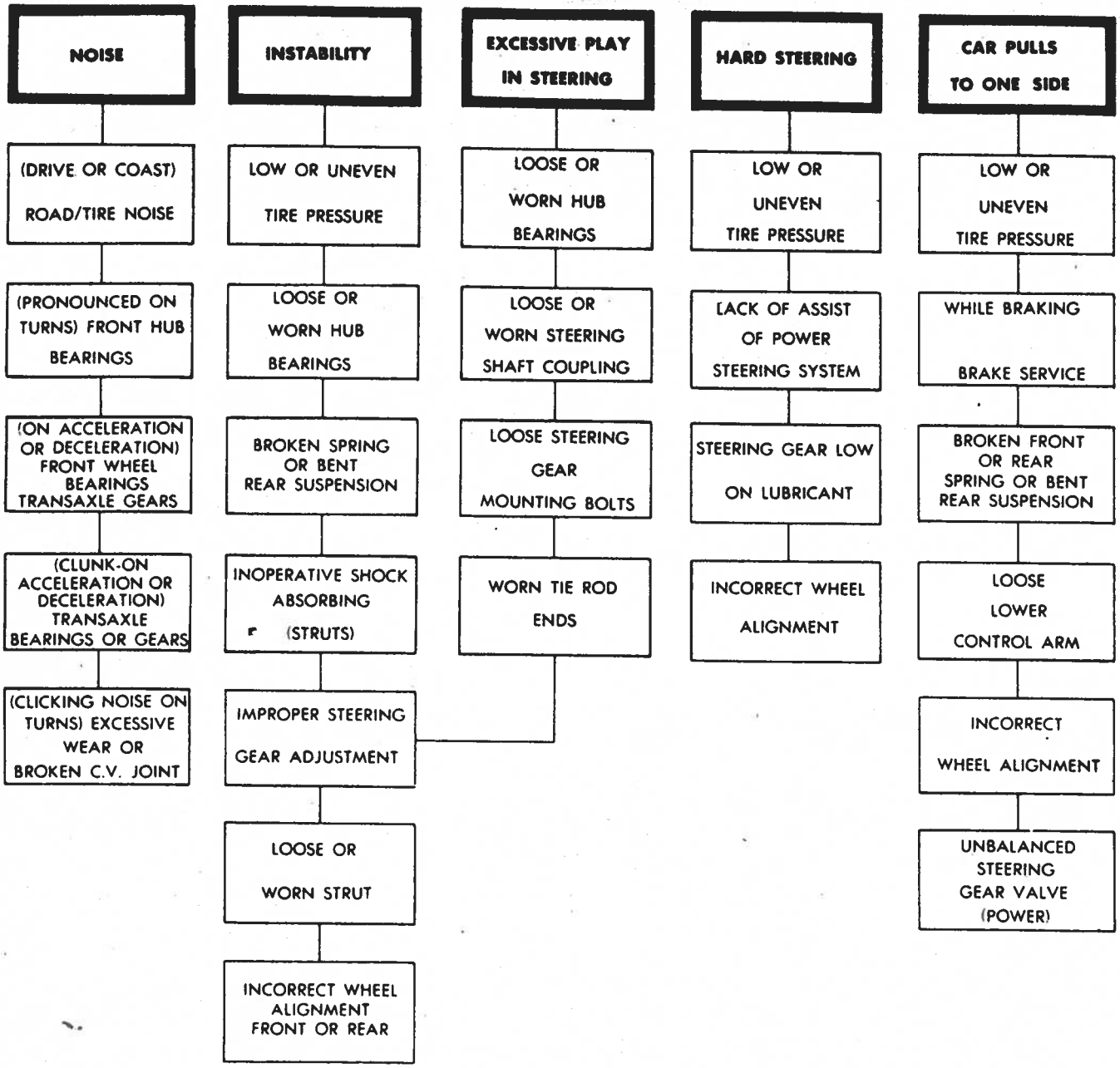
FRONT WHEEL SHIMMY
- LOOSE OR WORN WHEEL BEARINGS
- TIRE, WHEEL OUT OF BALANCE
- UNEVEN TIRE WEAR, OR EXCESSIVELY WORN TIRES
- WORN TIE ROD ENDS
- LOOSE OR WORN STRUT BUSHINGS
- LOOSE OR WORN UPPER CONTROL ARM BALL JOINTS
- INCORRECT FRONT WHEEL ALIGNMENT (PARTICULARLY CASTER)
- WORN SHOCK ABSORBER

INSTABILITY
- LOW OR UNEVEN TIRE PRESSURE
- LOOSE WHEEL BEARINGS
- BROKEN REAR SPRING
- SHOCK ABSORBER INOPERATIVE
- IMPROPER STEERING CROSS SHAFT ADJUSTMENT
- STEERING GEAR NOT CENTERED
- WORN IDLER ARM BUSHING
- LOOSE OR WORN STRUT BUSHINGS
- INCORRECT FRONT WHEEL ALIGNMENT

HARD STEERING
- LOW OR UNEVEN TIRE PRESSURE
- LACK OF ASSIST OF POWER STEERING SYSTEM
- STEERING GEAR NOT ADJUSTED
- INCORRECT FRONT WHEEL ALIGNMENT (PARTICULARLY CASTER)

CAR PULLS TO ONE SIDE
- BROKEN REAR SPRING
- POWER STEERING CONTROL VALVE OUT OF ADJUSTMENT
- LOOSE OR WORN STRUT BUSHINGS
- INCORRECT FRONT WHEEL ALIGNMENT (PARTICULARLY CASTER)

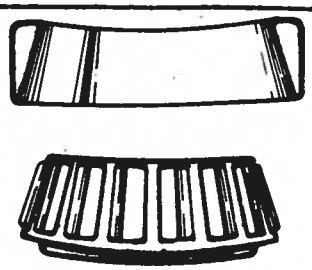
Suspension and Steering Linkage Troubleshooting— Front Wheel Drive



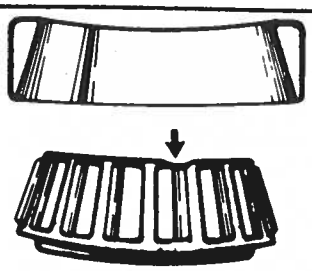
Tapered Wheel Bearing Troubleshooting

CONSIDER THE FOLLOWING FACTORS WHEN DIAGNOSING BEARING CONDITION:

1. GENERAL CONDITION OF ALL PARTS DURING DISASSEMBLY AND INSPECTION.
2. CLASSIFY THE FAILURE WITH THE AID OF THE ILLUSTRATIONS.
3. DETERMINE THE CAUSE.
4. MAKE ALL REPAIRS FOLLOWING RECOMMENDED PROCEDURES.



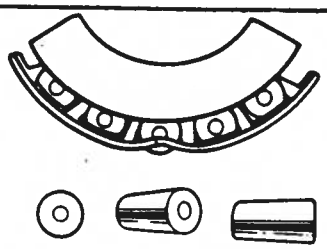
GOOD BEARING



BENT CAGE

CAGE DAMAGE DUE TO IMPROPER HANDLING OR TOOL USAGE.

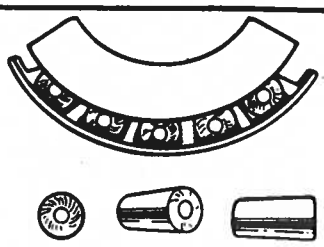
REPLACE BEARING.



BENT CAGE

CAGE DAMAGE DUE TO IMPROPER HANDLING OR TOOL USAGE.

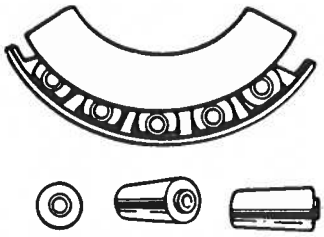
REPLACE BEARING.



GALLING

METAL SMEARS ON ROLLER ENDS DUE TO OVERHEAT, LUBRICANT FAILURE OR OVERLOAD.

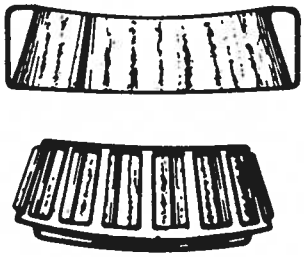
REPLACE BEARING – CHECK SEALS AND CHECK FOR PROPER LUBRICATION.



ABRASIVE STEP WEAR

PATTERN ON ROLLER ENDS CAUSED BY FINE ABRASIVES.

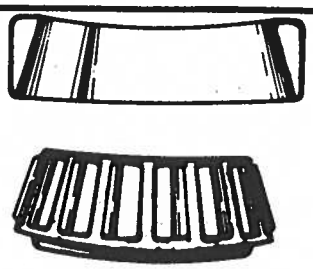
CLEAN ALL PARTS AND HOUSINGS, CHECK SEALS AND BEARINGS AND REPLACE IF LEAKING, ROUGH OR NOISY.



ETCHING

BEARING SURFACES APPEAR GRAY OR GRAYISH BLACK IN COLOR WITH RELATED ETCHING AWAY OF MATERIAL USUALLY AT ROLLER SPACING.

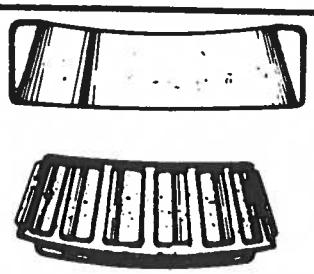
REPLACE BEARINGS – CHECK SEALS AND CHECK FOR PROPER LUBRICATION.



MISALIGNMENT

OUTER RACE MISALIGNMENT DUE TO FOREIGN OBJECT.

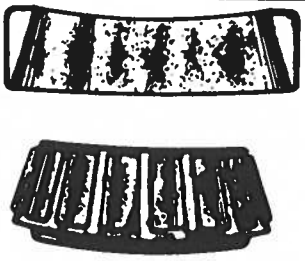
CLEAN RELATED PARTS AND REPLACE BEARING. MAKE SURE RACES ARE PROPERLY SEATED.



INDENTATIONS

SURFACE DEPRESSIONS ON RACE AND ROLLERS CAUSED BY HARD PARTICLES OF FOREIGN MATERIAL.

CLEAN ALL PARTS AND HOUSINGS, CHECK SEALS AND REPLACE BEARINGS IF ROUGH OR NOISY.

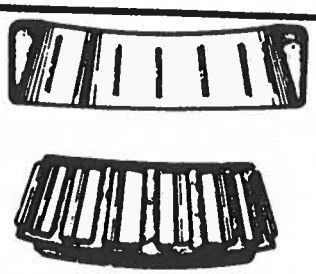


FATIGUE SPALLING

FLAKING OF SURFACE METAL RESULTING FROM FATIGUE.

REPLACE BEARING – CLEAN ALL RELATED PARTS.

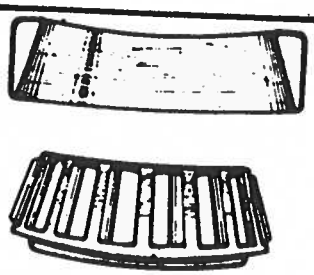
Tapered Wheel Bearing Troubleshooting



BRINELLING

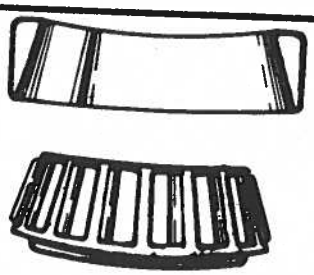
SURFACE INDENTATIONS IN RACEWAY CAUSED BY ROLLERS EITHER UNDER IMPACT LOADING OR VIBRATION WHILE THE BEARING IS NOT ROTATING.

REPLACE BEARING IF ROUGH OR NOISY.



CAGE WEAR

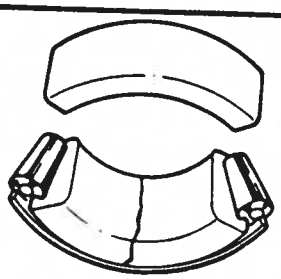
WEAR AROUND OUTSIDE DIAMETER OF CAGE AND ROLLER POCKETS CAUSED BY ABRASIVE MATERIAL AND INEFFICIENT LUBRICATION. CHECK SEALS AND REPLACE BEARINGS.



ABRASIVE ROLLER WEAR

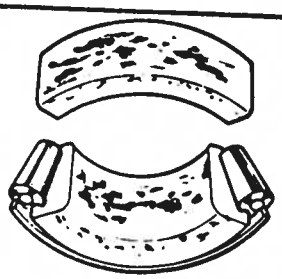
PATTERN ON RACES AND ROLLERS CAUSED BY FINE ABRASIVES.

CLEAN ALL PARTS AND HOUSINGS, CHECK SEALS AND BEARINGS AND REPLACE IF LEAKING, ROUGH OR NOISY.



CRACKED INNER RACE

RACE CRACKED DUE TO IMPROPER FIT, COCKING, OR POOR BEARING SEATS.

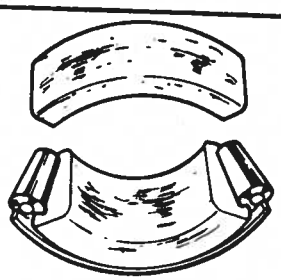


SMEARS

SMEARING OF METAL DUE TO SLIPPAGE, SLIPPAGE CAN BE CAUSED BY POOR FITS, LUBRICATION, OVERHEATING, OVERLOADS OR HANDLING DAMAGE.

REPLACE BEARINGS, CLEAN RELATED PARTS AND CHECK FOR PROPER FIT AND LUBRICATION.

REPLACE SHAFT IF DAMAGED.



FRETTAGE

CORROSION SET UP BY SMALL RELATIVE MOVEMENT OF PARTS WITH NO LUBRICATION.

REPLACE BEARING. CLEAN RELATED PARTS. CHECK SEALS AND CHECK FOR PROPER LUBRICATION.

HEAT DISCOLORATION

HEAT DISCOLORATION CAN RANGE FROM FAINT YELLOW TO DARK BLUE RESULTING FROM OVERLOAD OR INCORRECT LUBRICANT.

EXCESSIVE HEAT CAN CAUSE SOFTENING OF RACES OR ROLLERS.

TO CHECK FOR LOSS OF TEMPER ON RACES OR ROLLERS A SIMPLE FILE TEST MAY BE MADE. A FILE DRAWN OVER A TEMPERED PART WILL GRAB AND CUT META, WHEREAS, A FILE DRAWN OVER A HARD PART WILL GLIDE READILY WITH NO METAL CUTTING.

REPLACE BEARINGS IF OVER HEATING DAMAGE IS INDICATED. CHECK SEALS AND OTHER PARTS.

STAIN DISCOLORATION

DISCOLORATION CAN RANGE FROM LIGHT BROWN TO BLACK CAUSED BY INCORRECT LUBRICANT OR MOISTURE.

RE-USE BEARINGS IF STAINS CAN BE REMOVED BY LIGHT POLISHING OR IF NO EVIDENCE OF OVERHEATING IS OBSERVED.

CHECK SEALS AND RELATED PARTS FOR DAMAGE.

Manual Steering Troubleshooting

INSPECTION AND ALIGNMENT

Before any steering gear adjustments are made, it is recommended that the front end of the car be raised and a thorough inspection be made for stiffness or lost motion in steering gear, steering linkage and front suspension. Worn or damaged parts should be replaced, since a satisfactory adjustment of the steering gear cannot be obtained if bent or badly worn parts exist.

It is also very important that the steering gear be properly aligned in the car. Misalignment of the gear places a stress on the steering worm shaft, therefore a proper adjustment is impossible. To align the steering gear, loosen the mounting bolts to permit the gear to align itself. Check the steering gear mounting seat, and if there is a gap at any of the mounting bolts, proper alignment may be obtained by placing shims where excessive gap appears. Tighten the steering gear bolts. Alignment of the gear in the car is very important and should be done carefully so that a satisfactory, trouble-free gear adjustment may be obtained.

Condition	Possible Cause	Corrective Action
Hard steering	1. Low or uneven tire pressure. 2. Insufficient lubricant in the steering gear housing or in steering linkage. 3. Steering gear shaft adjusted too tight. 4. Front wheels out of line. 5. Steering column misaligned.	1. Inflate tires to recommended pressures. 2. Lubricate as necessary. 3. Adjust according to instructions. 4. Align the wheels. 5. See the appropriate Car Section for alignment procedures.
Excessive play or looseness in the steering wheel	1. Steering gear shaft adjust too loose or badly worn. 2. Steering linkage loose or worn. 3. Front wheel bearings improperly adjusted. 4. Steering arm loose on steering gear shaft. 5. Steering gear housing attaching bolts loose. 6. Steering arms loose at steering knuckles. 7. Worn ball joints. 8. Worm shaft bearing adjustment too loose.	1. Replace worn parts and adjust according to instructions. 2. Replace worn parts. 3. Adjust according to instructions. 4. Inspect for damage to the gear shaft and steering arm, replace parts as necessary. 5. Tighten attaching bolts to specifications. 6. Tighten according to specifications. 7. Replace the ball joints as necessary. 8. Adjust worm bearing preload according to instructions.

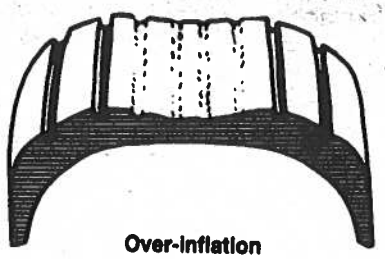
Power Steering Systems Troubleshooting

Condition	Possible Cause	Corrective Action
Hard steering	1. Improper tire pressure. 2. Loose pump drive belt. 3. Low or incorrect fluid. 4. Loose, bent or poorly lubricated front end parts. 5. Improper front end alignment. 6. Bind in steering column or linkage.	1. Inflate tires to recommended pressures. 2. Tighten or replace belt. 3. Refill reservoir with proper fluid; check for leaks; 4. Tighten or replace parts; lubricate at all fittings. 5. Align front end.

Condition	Possible Cause	Correction Action
Hard steering	7. Air in hydraulic system. 8. Low pump output or leaks in system. 9. Obstruction in lines. 10. Pump valves sticking or out of adjustment.	6. Disassemble and inspect component parts. Repair or replace as necessary. 7. Bleed system, refill and check for leaks. 8. Disassemble pump, check for worn or damaged parts. Check for leaks in the system. 9. Clean or replace lines. 10. Replace or adjust valves.
Loose steering	1. Loose wheel bearings 2. Faulty shocks. 3. Worn linkage components. 4. Loose steering gear mounting or linkage points. 5. Steering mechanism worn or improperly adjusted. 6. Valve spool improperly adjusted	1. Adjust wheel bearings. 2. Relace shocks. 3. Replace worn components. 4. Tighten mountings or linkage. 5. Replace and/or adjust mechanism. 6. Adjust valve spool.
Veer or wander	1. Improper tire pressure. 2. Improper front end alignment. 3. Dragging brakes. 4. Bent frame. 5. Improper rear end alignment. 6. Faulty shocks or springs. 7. Loose or bent front end components. 8. Play in Pitman arm. 9. Loose wheel bearings. 10. Binding Pitman arm. 11. Spool valve sticking or improperly adjusted.	1. Inflate tires to recommended pressures. 2. Align front end. 3. Inspect, replace and/or adjust brakes. 4. Straighten frame. 5. Inspect shocks and control arm torque. Replace and/or adjust as necessary. 6. Replace as necessary. 7. Replace as necessary. 8. Inspect bushings and arm. Replace as necessary. 9. Adjust to specifications. 10. Replace arm. 11. Adjust or replace as necessary.
Wheel oscillation	1. Improper tire pressure. 2. Loose wheel bearings. 3. Improper front end alignment. 4. Bent spindle. 5. Worn, bent or broken front end components. 6. Tires out of round or out of balance. 7. Excessive lateral runout in disc brake rotor.	1. Inflate tires to recommended pressures. 2. Adjust to specifications. 3. Align front end. 4. Replace spindle. 5. Inspect, repair or replace as necessary. 6. Replace or balance tires. 7. Reface or replace rotor.
Noises	1. Loose belts. 2. Low fluid, air in system. 3. Foreign matter in system. 4. Improper lubrication. 5. Interference or chafing in linkage. 6. Steering gear mountings loose. 7. Incorrect adjustment or wear in gear box. 8. Faulty valves or wear in pump.	1. Replace and/or adjust belts. 2. Refill and check for leaks. 3. Disassemble and clean system. 4. Lubricate all fittings. 5. Disassemble, inspect, replace or adjust components. 6. Tighten mountings. 7. Disassemble, inspect, repair, replace and/or adjust parts. 8. Replace parts as necessary.

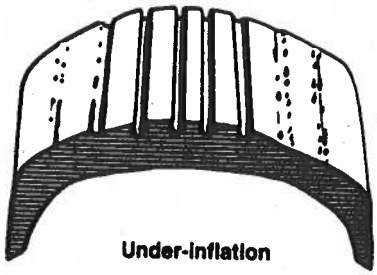
How To Read Tire Wear

The way your tires wear is a good indicator of other parts of the suspension. Abnormal wear patterns are often caused by the need for simple tire maintenance, or for front end alignment.



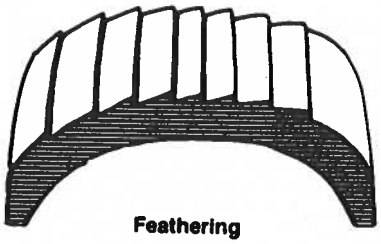
Over-inflation

Excessive wear at the center of the tread indicates that the air pressure in the tire is consistently too high. The tire is riding on the center of the tread and wearing it prematurely. Occasionally, this wear pattern can result from outrageously wide tires on narrow rims. The cure for this is to replace either the tires or the wheels.



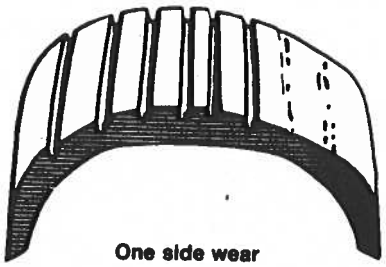
Under-inflation

This type of wear usually results from consistent under-inflation. When a tire is under-inflated, there is too much contact with the road by the outer treads, which wear prematurely. When this type of wear occurs, and the tire pressure is known to be consistently correct, a bent or worn steering component or the need for wheel alignment could be indicated.



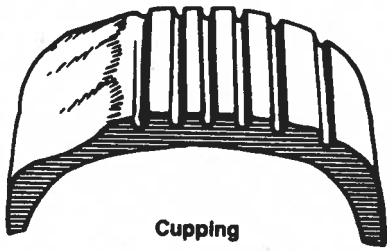
Feathering

Feathering is a condition when the edge of each tread rib develops a slightly rounded edge on one side and a sharp edge on the other. By running your hand over the tire, you can usually feel the sharper edges before you'll be able to see them. The most common causes of feathering are incorrect toe-in setting or deteriorated bushings in the front suspension.



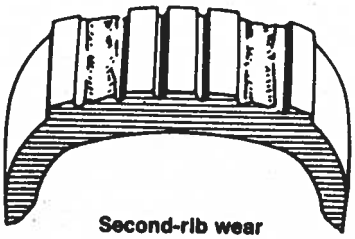
One side wear

When an inner or outer rib wears faster than the rest of the tire, the need for wheel alignment is indicated. There is excessive camber in the front suspension, causing the wheel to lean too much putting excessive load on one side of the tire. Misalignment could also be due to sagging springs, worn ball joints, or worn control arm bushings. Be sure the vehicle is loaded the way it's normally driven when you have the wheels aligned.



Cupping

Cups or scalloped dips appearing around the edge of the tread almost always indicate worn (sometimes bent) suspension parts. Adjustment of wheel alignment alone will seldom cure the problem. Any worn component that connects the wheel to the suspension can cause this type of wear. Occasionally, wheels that are out of balance will wear like this, but wheel imbalance usually shows up as bald spots between the outside edges and center of the tread.



Second-rib wear

Second-rib wear is usually found only in radial tires, and appears where the steel belts end in relation to the tread. It can be kept to a minimum by paying careful attention to tire pressure and frequently rotating the tires. This is often considered normal wear but excessive amounts indicate that the tires are too wide for the wheels.

Drum Brake Troubleshooting

Condition	Possible Cause	Correction Action
Pedal goes to floor	1. Fluid low in reservoir. 2. Air in hydraulic brake system. 3. Improperly adjusted brake. 4. Leaking wheel cylinders. 5. Loose or broken brake lines. 6. Leaking or worn master cylinder. 7. Excessively worn brake lining.	1. Fill and bleed master cylinder. 2. Fill and bleed hydraulic brake system. 3. Repair or replace self-adjuster as required. 4. Recondition or replace wheel cylinder and replace both brake shoes. 5. Tighten all brake fittings or replace brake line. 6. Recondition or replace master cylinder and bleed hydraulic system. 7. Reline and adjust brakes.
Spongy brake pedal	1. Air in hydraulic system. 2. Improper brake fluid (low boiling point). 3. Excessively worn or cracked brake drums. 4. Broken pedal pivot bushing.	1. Fill master cylinder and bleed hydraulic system. 2. Drain, flush and refill with brake fluid. 3. Replace all faulty brake drums. 4. Replace nylon pivot bushing.
Brakes pulling	1. Contaminated lining. 2. Front end out of alignment. 3. Incorrect brake adjustment. 4. Unmatched brake lining. 5. Brake drums out of round. 6. Brake shoes distorted. 7. Restricted brake hose or line. 8. Broken rear spring.	1. Replace contaminated brake lining. 2. Align front end. 3. Adjust brakes and check fluid. 4. Match primary, secondary with same type of lining on all wheels. 5. Grind or replace brake drums. 6. Replace faulty brake shoes. 7. Replace plugged hose or brake line. 8. Replace broken spring.
Squealing brakes	1. Glazed brake lining. 2. Saturated brake lining. 3. Weak or broken brake shoe retaining spring. 4. Broken or weak brake shoe return spring. 5. Incorrect brake lining. 6. Distorted brake shoes. 7. Bent support plate. 8. Dust in brakes or scored brake drums.	1. Cam grind or replace brake lining. 2. Replace saturated lining. 3. Replace retaining spring. 4. Replace return spring. 5. Install matched brake lining. 6. Replace brake shoes. 7. Replace support plate. 8. Blow out brake assembly with compressed air and grind brake drums.
Chirping brakes	1. Out of round drum or eccentric axle flange pilot.	1. Repair as necessary, and lubricate support plate contact areas (6 places).
Dragging brakes	1. Incorrect wheel or parking brake adjustment. 2. Parking brakes engaged. 3. Weak or broken brake shoe return spring. 4. Brake pedal binding. 5. Master cylinder cup sticking. 6. Obstructed master cylinder relief port. 7. Saturated brake lining. 8. Bent or out of round brake drum.	1. Adjust brake and check fluid. 2. Release parking brakes. 3. Replace brake shoe return spring. 4. Free up and lubricate brake pedal and linkage. 5. Recondition master cylinder. 6. Use compressed air and blow out relief port. 7. Replace brake lining. 8. Grind or replace faulty brake drum.

Condition	Possible Cause	Corrective Action
Hard pedal	1. Brake booster inoperative. 2. Incorrect brake lining. 3. Restricted brake line or hose. 4. Frozen brake pedal linkage.	1. Replace brake booster. 2. Install matched brake lining. 3. Clean out or replace brake line or hose. 4. Free up and lubricate brake linkage.
Wheel locks	1. Contaminated brake lining. 2. Loose or torn brake lining. 3. Wheel cylinder cups sticking. 4. Incorrect wheel bearing adjustment.	1. Reline both front or rear of all four brakes. 2. Replace brake lining. 3. Recondition or replace wheel cylinder. 4. Clean, pack and adjust wheel bearings.
Brakes fade (high speed)	1. Incorrect lining. 2. Overheated brake drums. 3. Incorrect brake fluid (low boiling temperature) 4. Saturated brake lining.	1. Replace lining. 2. Inspect for dragging brakes. 3. Drain, flush, refill and bleed hydraulic brake system. 4. Reline both front or rear or all four brakes.
Pedal pulsates	1. Bent or out of round brake drum.	1. Grind or replace brake drums.
Brake chatter and shoe knock	1. Out of round brake drum. 2. Loose support plate. 3. Bent support plate. 4. Distorted brake shoes. 5. Machine grooves in contact face of brake drum. (Shoe Knock). 6. Contaminated brake lining.	1. Grind or replace brake drums. 2. Tighten support plate bolts to proper specifications. 3. Replace support plate. 4. Replace brake shoes. 5. Grind or replace brake drum. 6. Replace either front or rear or all four linings.
Brakes do not self adjust	1. Adjuster screw frozen in thread. 2. Adjuster screw corroded at thrust washer. 3. Adjuster level does not engage star wheel. 4. Adjuster installed on wrong wheel.	1. Clean and free-up all thread areas. 2. Clean threads and replace thrust washer if necessary. 3. Repair, free up or replace adjusters as required. 4. Install correct adjuster parts.

Disc Brake Troubleshooting

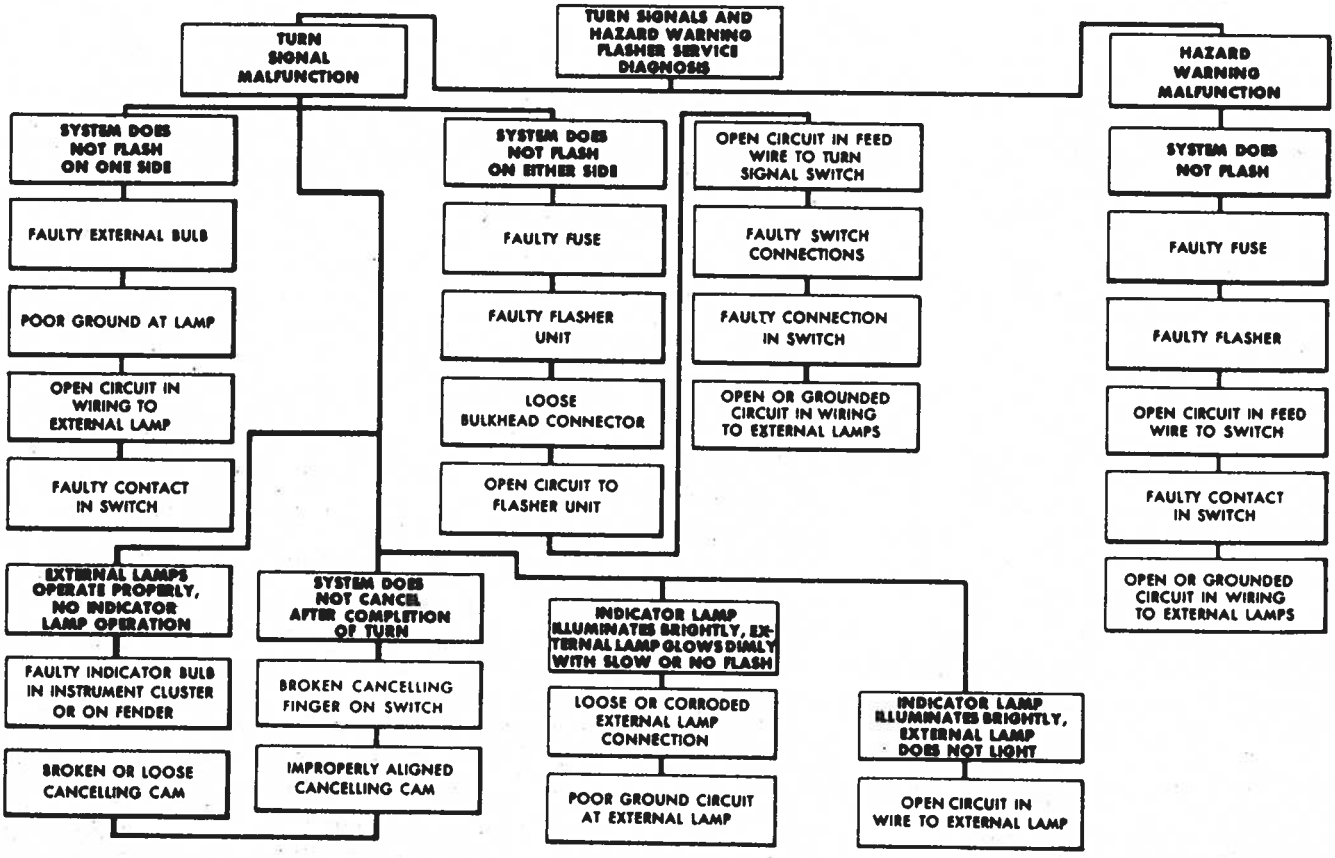
Condition	Possible Cause	Correction Action
Noise—Groan—Brake noise emanating when slowly releasing brakes (creep-groan).	1.. Not detrimental to function of disc brakes—no corrective action required. (Indicate to operator this noise may be eliminated by slightly increasing or decreasing brake pedal efforts.)	
Rattle—Brake noise or rattle emanating at low speeds on rough roads, (front wheels only).	1. Shoe anti-rattle spring missing or not properly positioned. 2. Excessive clearance between shoe and caliper.	1. Install new anti-rattle spring or position properly. 2. Install new shoe and lining assemblies.

Condition	Possible Cause	Corrective Action
Scraping	1. Mounting bolts too long. 2. Loose wheel bearings.	1. Install mounting bolts of correct length. 2. Readjust wheel bearings to correct specifications.
Front brakes heat up during driving and fail to release	1. Operator riding brake pedal. 2. Stop light switch improperly adjusted. 3. Sticking pedal linkage. 4. Frozen or seized piston. 5. Residual pressure valve in master cylinder. 6. Power brake malfunction.	1. Instruct owner how to drive with disc brakes. 2. Adjust stop light to allow full return of pedal. 3. Free up sticking pedal linkage. 4. Disassemble caliper and free up piston. 5. Remove valve. 6. Replace.
Leaky wheel cylinder	1. Damaged or worn caliper piston seal. 2. Scores or corrosion on surface of cylinder bore.	1. Disassemble caliper and install new seal. 2. Disassemble caliper and hone cylinder bore. Install new seal.
Grabbing or uneven brake action	1. Causes listed under "Pull." 2. Power brake malfunction.	1. Corrections listed under "Pull". 2. Replace.
Brake pedal can be depressed without braking effect	1. Air in hydraulic system or improper bleeding procedure. 2. Leak past primary cup in master cylinder. 3. Leak in system. 4. Rear brakes out of adjustment. 5. Bleeder screw open.	1. Bleed system. 2. Recondition master cylinder. 3. Check for leak and repair as required. 4. Adjust rear brakes. 5. Close bleeder screw and bleed entire system.
Excessive pedal travel	1. Air, leak, or insufficient fluid in system or caliper. 2. Warped or excessively tapered shoe and lining assembly. 3. Excessive disc runout. 4. Rear brake adjustment required. 5. Loose wheel bearing adjustment. 6. Damaged caliper piston seal. 7. Improper brake fluid (boil). 8. Power brake malfunction.	1. Check system for leaks and bleed. 2. Install new shoe and linings. 3. Check disc for runout with dial indicator. Install new or refinished disc. 4. Check and adjust rear brakes. 5. Readjust wheel bearing to specified torque. 6. Install new piston seal. 7. Drain and install correct fluid. 8. Replace.
Brake roughness or chatter (pedal pumping)	1. Excessive thickness variation of braking disc. 2. Excessive lateral runout of braking disc. 3. Rear brake drums out-of-round. 4. Excessive front bearing clearance.	1. Check disc for thickness variation using a micrometer. 2. Check disc for lateral runout with dial indicator. Install new or refinished disc. 3. Reface rear drums and check for out-of-round. 4. Readjust wheel bearings to specified torque.
Excessive pedal effort	1. Brake fluid, oil or grease on linings. 2. Incorrect lining. 3. Frozen or seized pistons. 4. Power brake malfunction.	1. Install new shoe linings as required. 2. Remove lining and install correct lining. 3. Disassemble caliper and free up pistons. 4. Replace.

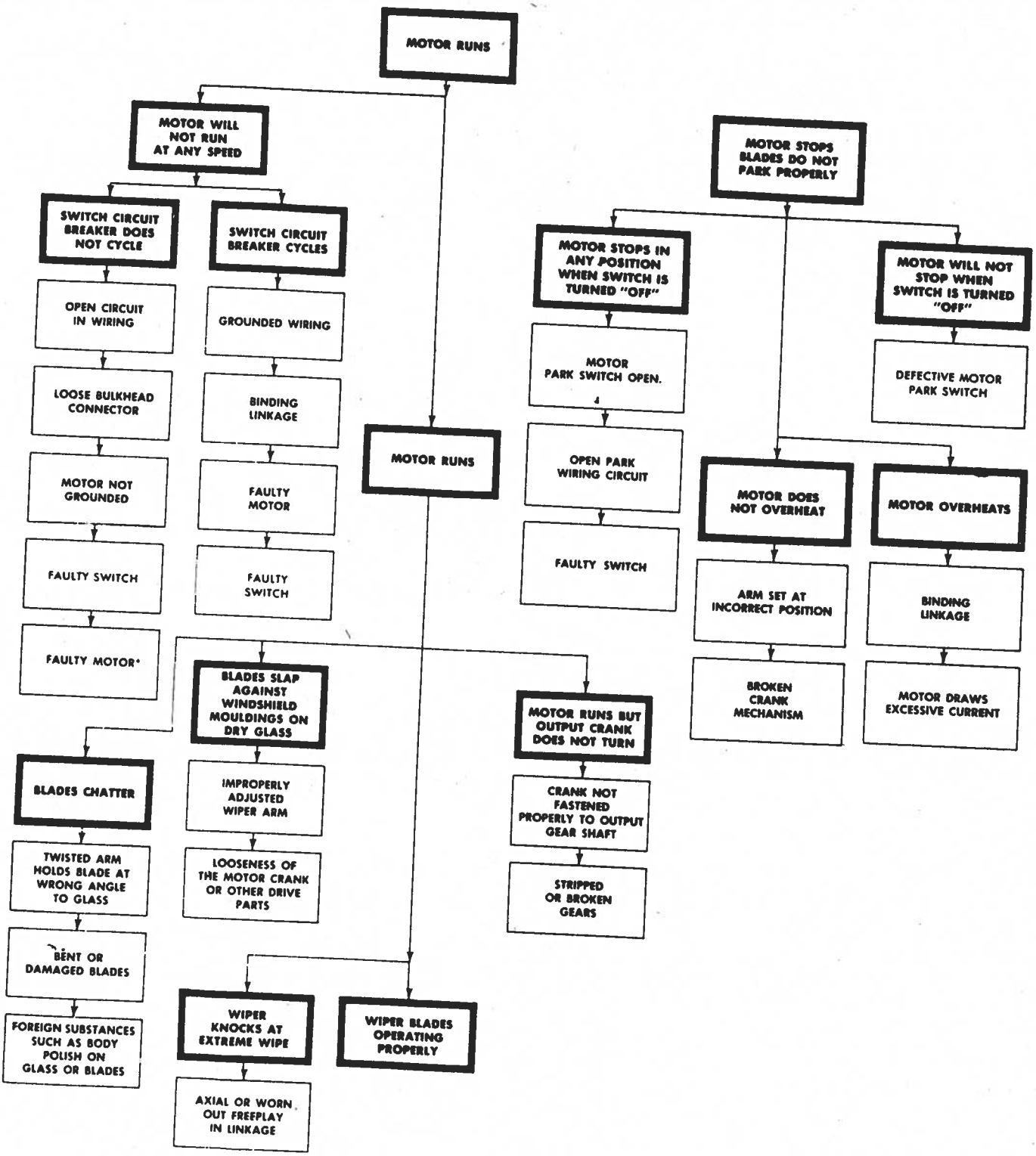
Condition	Possible Cause	Corrective Action
Pull	1. Brake fluid, oil or grease on linings. 2. Unmatched linings. 3. Distorted brake shoes. 4. Frozen or seized pistons. 5. Incorrect tire pressure. 6. Front end out of alignment. 7. Broken rear spring. 8. Rear brake pistons sticking. 9. Restricted hose or line. 10. Caliper not in proper alignment to braking disc.	1. Install new shoe and linings. 2. Install correct lining. 3. Install new brake shoes. 4. Disassemble caliper and free up pistons. 5. Inflate tires to recommended pressures. 6. Align front end and check. 7. Install new rear spring. 8. Free up rear brake pistons. 9. Check hoses and lines and correct as necessary. 10. Remove caliper and reinstall. Check alignment.

ELECTRICAL

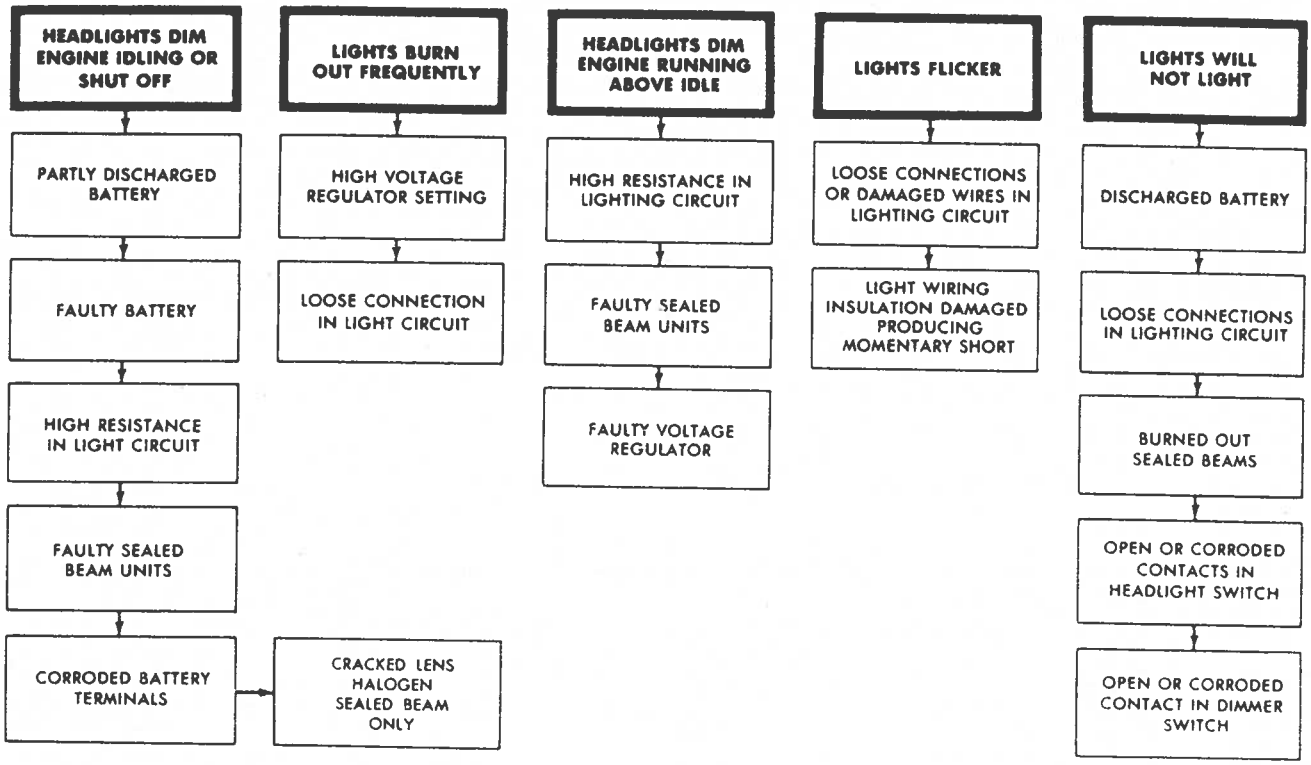
Turn Signal and Flasher Troubleshooting



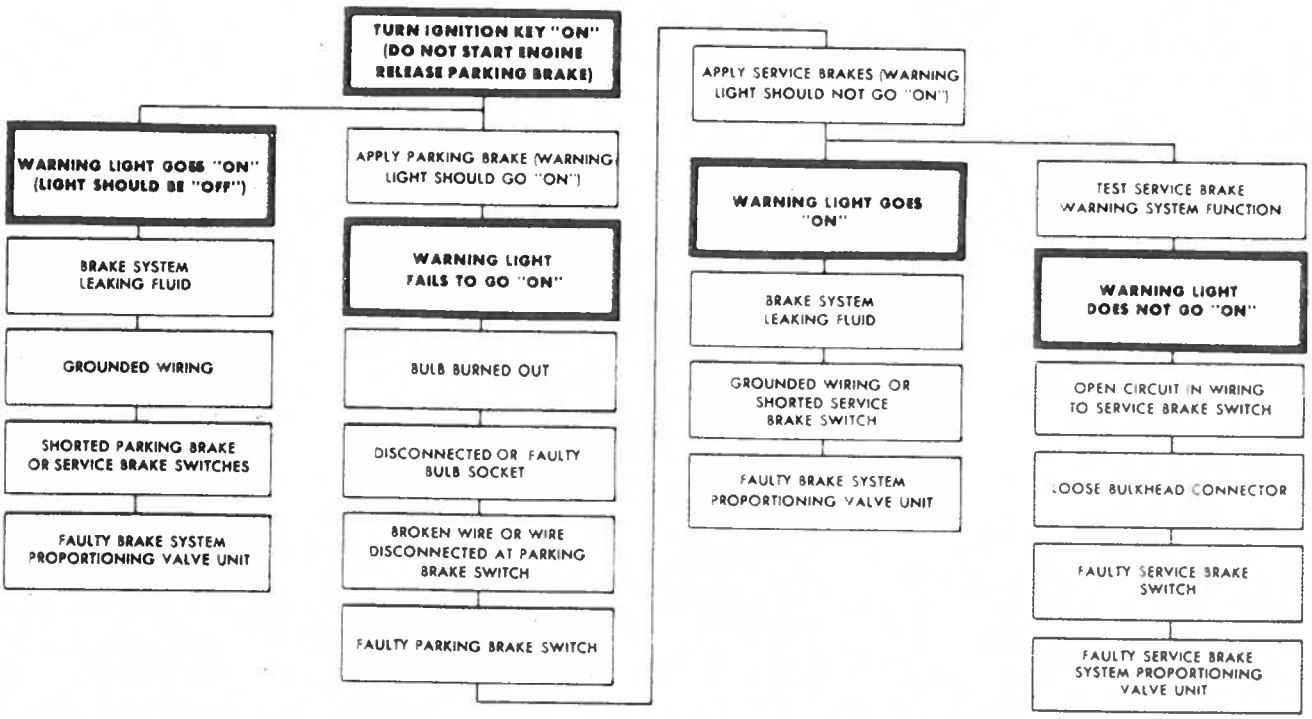
Windshield Wiper Troubleshooting



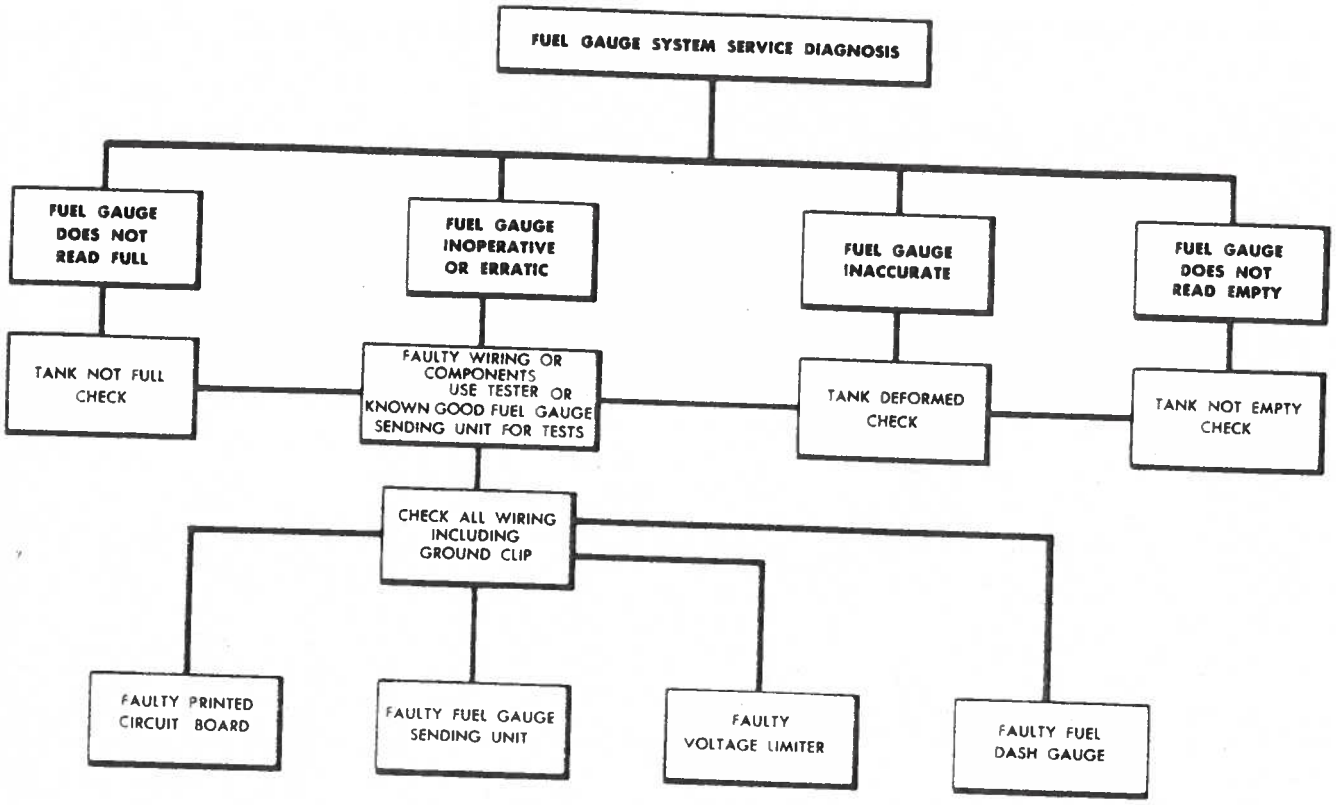
Headlamp Troubleshooting



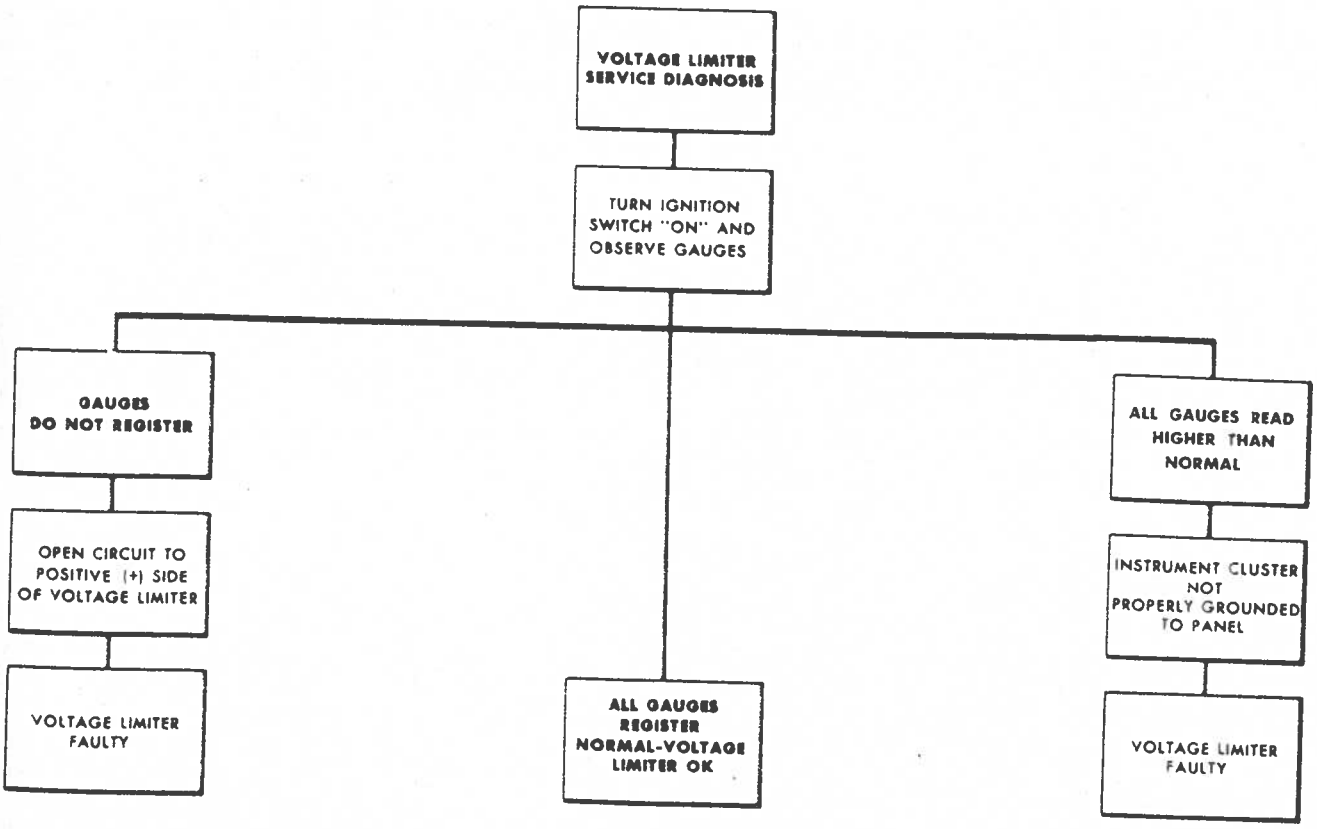
Brake System Warning Light Troubleshooting



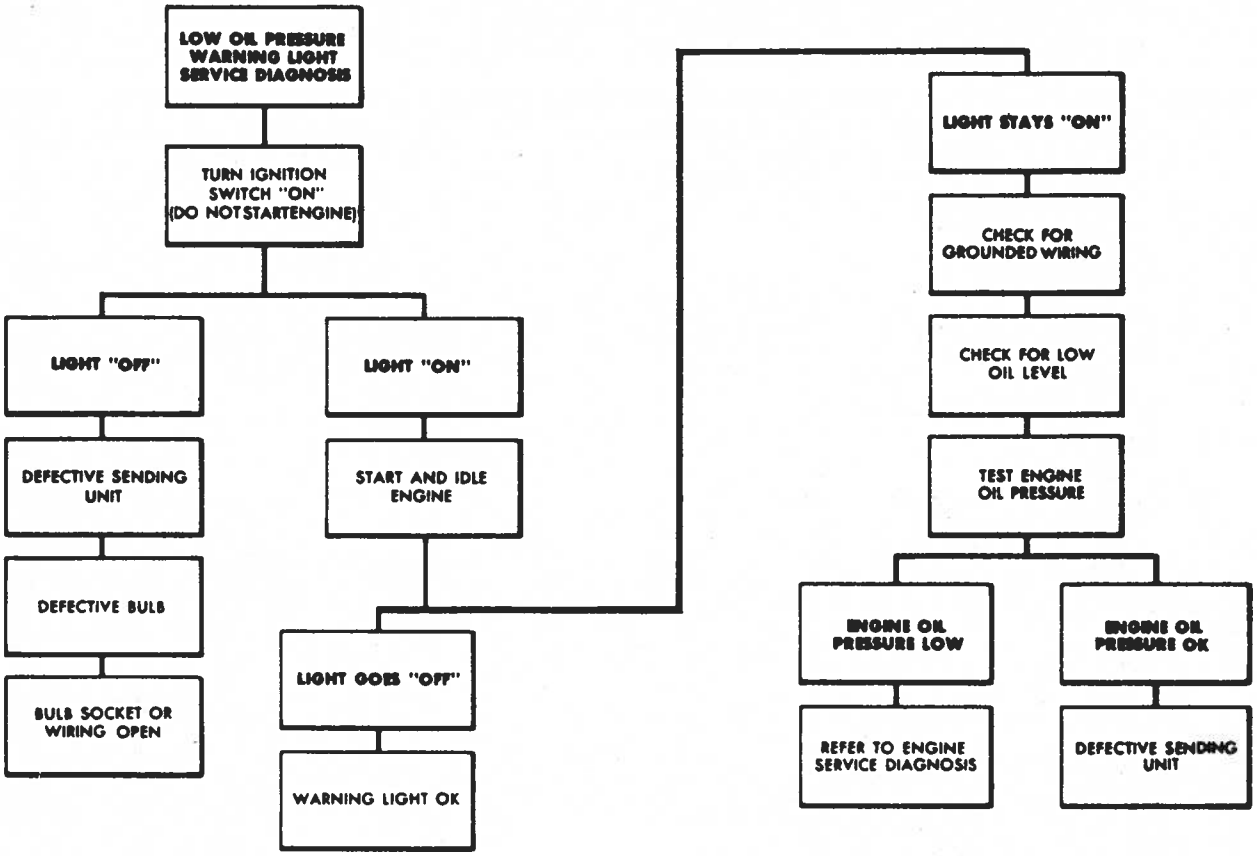
Fuel Gauge System Troubleshooting



Voltage Limiter Troubleshooting



Low Oil Pressure Warning Light Troubleshooting



Temperature Gauge Troubleshooting

TEMPERATURE GAUGE INDICATES HIGHER OR LOWER TEMPERATURE THAN ACTUAL ENGINE TEMPERATURE

- FAULTY WIRING
- FAULTY TEMPERATURE SENDING UNIT
- FAULTY VOLTAGE LIMITER
- FAULTY INSTRUMENT PANEL TEMPERATURE GAUGE

ERRATIC TEMPERATURE GAUGE OPERATION

- LOOSE OR DIRTY ELECTRICAL CONNECTIONS
- FAULTY INSTRUMENT PANEL TEMPERATURE GAUGE

Temperature Warning Light Troubleshooting

TEMPERATURE WARNING LAMP LIGHTS AT ALL TIMES IGNITION SWITCH IS ON

- FAULTY WIRING
- FAULTY SENDING UNIT

TEMPERATURE WARNING LAMP DOES NOT LIGHT

- BURNED OUT BULB
- FAULTY WIRING
- FAULTY SENDING UNIT